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L'EXPLORATION GÉOLOGIQUE
ET MINÉRALE

STRATIGRAPHY OF PART OF THE CENTRAL LABRADOR TRHOUGH

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Stratigraphy of Part of the

CENTRAL LABRADOR TROUGH

(Between Latitude 56°30' and the Height of Land)

by

Erich Dimroth

QUEBEC
1972

INTRODUCTION

Location and access

The area described in this report is situated in north-eastern Quebec, approximately 600 miles northeast of Quebec City. It comprises a northwest trending zone, some 120 miles long and approximately 60 miles wide, bounded in the north by latitude 56°30', and in the south by the divide between the drainage basins of Ungava Bay and of the St. Lawrence Gulf. Maps accompanying this open file report, however, cover only the part of this area bounded by latitude 55°30'N in the south. The following map sheets are issued with this open file report:

Scale 1 inch equals ½ mile (appr. 1:32,000):

1. Romanet Lake area: lat. 56°15'N and 56°30'N, long. 67°30'W and 68°00'W.
2. Otelnuk Lake area: lat. 56°00'N and 56°15'N, long. 68°00'W and 68°30'W.

Compilation maps on scale of 1:62,500 (appr. 1 inch equals 1 mile):

1.	Castignon Lake	lat. 56°00' and 56°30', long. 68°00' and 69°00'
2.	Wheeler River voir GM-27779	lat. 56°00' and 56°30', long. 67°00' and 68°00'
3.	Granite Falls	lat. 55°30' and 56°00', long. 68°00' and 69°00'
4.	Cramolet Lake, voir GM-27779	lat. 55°30' and 56°00', long. 67°00' and 68°00'
5.	Lac Vannes	lat. 55°30' and 56°00', long. 66°00' and 67°00'

The mining town of Schefferville (pop. 3,500), is situated at the southern boundary of the area. The northern limit of the area is more than halfway between Schefferville and Fort Chimo.

Schefferville is presently rail head of Quebec North Shore and Labrador Railway and has regular passenger service to Seven Islands. It is also served by regular scheduled aircraft from Montreal, Quebec, Seven Islands, Wabush, and Churchill Falls. Some of the terrain adjacent to Schefferville is accessible by wagon roads. The remaining 95 per cent of the area are easily reached by float- or ski-equipped aircraft. Most of the larger lakes of the area are suited for aircraft landing. There are however a few zones where lakes are shallow and where suitable landing sites are not easily encountered. These are particularly the zones northeast of Effiat Lake, at Gustafsson and Aubin Lake, and southwest of Wakuach Lake. On the whole, however, the area is easily accessible, and there are few places more than 4 miles distant from the next suitable landing site. Chartered aircraft service is available in Schefferville, where Squaw Lake, about 5 miles east of the town site, serves as air base.

The area is close to the height of land; rivers are small and rapid. Canoe travel on rivers is therefore not a practical means of transport in the area, although it is occasionally used by sportsmen. The historical route from Fort Chimo to the North Shore of the St. Lawrence follows Swampy Bay River through the area. In eight years of field work the writer has seen two parties of sportsmen travelling this route.

History of Exploration

Father Louis Babel, O.M.I., made several trips to the interior of Quebec-Labrador between 1866 and 1870. He compiled a remarkably accurate map, and noted the occurrence of iron formation south of the present area.

A.P. Low (1897) intersected the area in the south and in the northwest during his historical voyages across northern Quebec, and thereby established the presence of a belt of weakly metamorphosed sedimentary and volcanic rocks in this part of the Province. Virtually no work was done subsequently, until the 1930ies. In the 1930ies a party led by J.E. Gill visited areas around Wabush, south of the area, and at Schefferville, and in 1936 J.E. Gill discovered what is now the Ruth Lake No. 1 iron ore deposit. Subsequently concessions were granted to Hollinger North Shore Exploration Company and to Norancon Exploration Company. Intense search for iron ore and heavy metal deposits started in the 1940ies. Most of the area south of 55°50' was mapped by Hollinger North Shore Exploration Company, by Labrador Mining and Exploration Company, and by Iron Ore Company of Canada before 1955. Geologists of these companies also established the stratigraphical sequence in the Schefferville region, and sponsored a great number of Ph.D. and M.Sc. theses concerned with the stratigraphy, mineralogy, petrography and structure of parts of the iron ore bearing zone in the west of the Labrador trough. Geologists of Norancon Exploration Company mapped parts of the country southwest of Otelnuk Lake, and Bergeron (1954) mapped parts of the area west of Hematite Lake.

The Geological Survey of Canada started work in this part of the Labrador trough in the late 1940ies. Harrison (1952) mapped a detailed traverse across the western part of the trough close to Schefferville and outlined the stratigraphy (Harrison, 1952; Harrison et al., 1972). Frarey (1967), Fahrig (1961), and Baragar (1967) mapped four 30-minute by 15-minute sheets in the east of the area in detail. Finally maps on a scale of four miles equal one inch were published by the Geological Survey of Canada (Fahrig, 1955, 1956a, 1956b, Roscoe, 1957, Baragar, 1967, Stevenson, 1963, Frarey, 1961).

Geologists of the Geological Survey of Canada formalized and refined the stratigraphy of the Schefferville area (Harrison, 1952; Harrison et al., 1972) and extended it to the eastern Labrador trough and north to 56°00' (Frarey and Duffell, 1964; Baragar, 1967; Frarey, 1967). Much work on the petrology of the mafic and ultramafic rocks of the eastern Labrador trough has been done (Fahrig, 1962; Baragar, 1960, 1967), and some sedimentological work on dolomites was done (Donaldson, 1963, 1966). The geological setting and economic geology of the iron ore deposits has been studied by Gross (1962, 1968). Articles synthesizing the geology of large parts, or of the whole, of the trough have been published by Bergeron (1957a, 1965), Fahrig (1957), Gastil et al. (1960), Baragar (1967), Gross (1968) and Donaldson (1970).

As noted above a great number of unpublished M.Sc. and Ph.D. theses have been sponsored by mining companies. The most important of these are by Kirkland (1950), Dufresne (1952), Kavanagh (1959), Schwellnus (1957), Bergeron (1959), Howell (1959), Perrault (1959), and Sauvé (1959).

Field work and basis for the compilation

The writer's field work in the area started in 1963, when the Romanet Lake area was mapped. The Otelnuk Lake area followed in 1964, the Dunphy Lake area in 1965, and the Castignon Lake area, comprising three 30 by 15 minute sheets, in 1966. Preliminary maps of these areas have been published (Dimroth 1964, 1965, 1967, 1969). In 1967 parts of the Romanet, Otelnuk and Castignon Lake areas were remapped. In 1968 the writer mapped the Granite Falls sheet, measured a number of stratigraphic sections in the southwest of the area, mapped all of the previously unmapped zones south of 56°00', and studied whether it was feasible to improve the existing maps south of 56°00' on the basis of aerial photo interpretation combined with extensive field checks. In 1969 the Effiat Lake area, the Swampy Bay river zone, and parts of Bacchus Lake area were mapped and extensive field work was done in the central part of the trough as field check for aerial photo interpretation. Futher stratigraphic sections were measured and some detailed tectonic work was done in 1970.

The writer is heavily indebted to surveys of Iron Ore Company of Canada and to the Geological Survey of Canada (Fahrig, 1964;

Stevenson, 1963; Baragar, 1967; Frarey, 1961, 1967) for the compilation of the terrain south of lat. 56°00'N. All areas mapped at scales of 1 inch equals 1 mile by geologists of the Geological Survey of Canada were compiled without changes. A narrow strip in the west of the Wakuach Lake and Granite Falls area, mapped at a scale of 1 inch equals 1,000 feet by Iron Ore of Canada, has also been compiled without substantial changes. The Corrugated Hills area has been compiled from an unpublished map by Gérard Woussen, now of the University of Quebec at Chicoutimi.

The other parts of the compiled area south of 56°00'N were remapped by the writer. However extensive aerial photo interpretation done before the field work, would not have been so successful, had there been no previous maps, and the existing maps were also very useful during the subsequent field checks. All sources of the compilation are noted in the legend accompanying the compilation maps.

Acknowledgments

Many field assistants contributed to the mapping, and their conscientious and reliable work is sincerely acknowledged. The following assistants took part of the mapping: Robert F. Ball (1966), Raymond Bargiel (1965), François Bérard (1968), François Béland (1968), Serge Boulanger (1967), François Bron (1967), Steve D'Appollonia (1969), Normand Goulet (1966), Paul E. Grattan-Bellew (1963), Jean-Paul Guelpa (1969), Michel Hocq (1968), Gert Ott (1969, 1970), Giselher Propach (1966), Paul W. Ransom (1964, 1965), Daniel Rota (1963, 1966), Bruno

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Paul Avoine was camp cook and dispatcher during the whole period; the canoemen, all of them very competent, were: Jean-Baptiste Bacon (1963), Thomas Bacon (1964-1970), Jean-Marie Bacon (1968, 1969), Moïse Bacon (1969), Raoul Fontaine (1966), Lucien Hervieux (1964, 1966-1969), Lazare Hervieux (1970), Maleck Hervieux (1969), Jean-Louis Vallée (1965), and Joseph Vachon (1966), all from Bersimis, Saguenay; and Daniel Memeanskum (1968), Robert Pien (1970) and Jérôme St-Onge (1969) from Schefferville. They were good comrades in the field and contributed greatly to the spirit prevailing in my field parties.

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Last but not least I want to acknowledge my debt of gratitude to other institutions that supported this work, in particular the Laboratories Branch, supplying numerous rock analyses and some mineral determinations, and Laurentian Air Service, who in addition to providing transport, rendered numerous services.

Rock terminology

The writer follow's the textbook by Pettijohn (1957) in classification and nomenclature of sedimentary rocks. In particular the term "greywacke" designates sandstones containing over 15 per cent matrix, whereas "arkose" is used for rocks containing a considerable feldspar component, but devoid of matrix. Subdivisions of greywackes follow Okada (1971). The term "calcarenite" is used for sandstones that contain calcareous or dolomite fragments derived from the basin (intraclasts), in addition to detrital components. Rocks containing clastic fragments of limestone coming from outside the basin are called "calcilithite". Sandstones devoid of calcareous fragments, but with a dolomitic cement, are called "dolomitic sandstone". The terminology of limestones follows Folk (1959, 1962), except that the term "calcilutite" is also used as an equivalent of "micrite". The terminology of the iron bearing rocks has been outlined by Dimroth (1968) and Dimroth and Chauvel (1973). Terms of sedimentary petrology are used for metamorphosed rocks, wherever the original material is clearly recognizable.

The terminology of igneous rocks follows Irvine and Baragar (1971), and the terminology of metamorphic rocks is equivalent to that used in the textbook by Turner (1968), except for migmatites. Migmatite classification follows Mehnert (1968).

GENERAL DESCRIPTION OF THE AREA

Physiography

The area is part of the plateau of northern Quebec and Labrador. The general level of the plateau is at about 2,000 feet in the south and at about 1,200-1,500 feet in the north. It culminates in a succession of hill chains that are up to 2,800 feet high in the south and up to 2,400 feet high in the north.

Three topographic zones, in the southwest, centre, and northeast, correspond to the main geological subdivisions. The area southwest of the Labrador trough, underlain by Archaean gneisses, is characterized by bold, flat-topped hills, with a local relief that varies greatly from 200 feet to more than 1,000 feet. Sharp linear valleys, trending in a variety of directions, form a polygonal pattern due to jointing and small faults, that is typical of this domain underlain by high grade granitoid gneisses.

The central zone of the area is underlain by the folded strata of the Labrador trough, and is therefore characterized by cuestas and hogsback ridges, that trace the structures of the underlying rocks. However only those folds are traced accurately that have a wave length exceeding 1 mile. Very closely folded and imbricated quartzites and iron formations therefore form broad hills that show some minor topographic lineations parallel to the stratification, as they predominate in the western part of the central zone. Shales on the other hand underlie wide marshy basins of which the largest extend along Swampy Bay river. Cuestas and hogsback hills trace particularly the structures of alternating gabbros and shales in the eastern part of the central physiographic zone.

The eastern physiographic zone is underlain by schists and gneisses. Local relief generally does not exceed 100 or 200 feet and muskeg and boulder plains mantle the bedrock.

A glacial landscape, whose typical landforms are drumlins and drumlinoids is superposed on the bedrock controlled features of the landscape. Wahsboard or cyclic moraines (described by Henderson 1959, pp. 18-23), occupy part of the Hurst Lake-Chassin Lake valley, areas east of lac Low and Keato Lake, northwest of Otelnuk Lake, and south of Castignon Lake. They are composed of rudely parallel ridges spaced at 1/8 mile interval. The ridges are oriented subperpendicular to the direction of ice flow. Sand plains extend along much of the valley between Hurst Lake and Low Lake, and along parts of Wheeler River and of Swampy Bay River. A few Eskers trend generally NW-SE. Glacial features indicate ice flow to the northwest or north.

Climate and Ecology

The region is in the subarctic climatic zone. Break-up is commonly in mid-June, and freeze-up in October. Night frost occrus regularly in June and September, and is not uncommon during the first 10 days of July as well as in late August. The first snow commonly falls end of August, or in early September. Temperatures range in the 40ies and 60ies in June and August, and in the 50ies and 70ies in July. Maximum temperature observed was 88°. Sudden drops of temperatures, exceeding 50° in a few hours, have been observed. Heavy rain-fall is not very common, but drizzling rain or showers may be expected to prevail through most of the summer. Heavy winds are common and render navigation on lakes hazardous.

The area is within the forest-tundra zone. Hilltops are generally barren. Open woodland occupies the valleys and basins. Alder and willow thickets cover some bouldery stretches and talus slopes but commonly are not very extensive.

Spruce and tamarack are the most common trees. Poplar and birch occur here and there at sheltered locations. Moose and beaver were observed here and there in the lowlands where they still encounter satisfactory food. Otter, martin, mink, lynx, wolf have been seen. Caribou and bear are reasonably common, and water fowl (geese, duck) are plentiful. The area is rightfully famous for its good fishing (trout, pike).

Natural Resources

Hydro-electric power is the only natural resource of the area, except for its mineral wealth. Small rapids and falls of Swampy Bay and Wheeler Rivers are probably sufficient for the purpose of local developments. A very great amount of hydro-electric energy is available at Granite Falls and Eaton's Canyon of Kaniapiskau River.

The local supply of wood is sufficient for local bush camps, but is too slow growing and too small for economic usage. A few hunting and fishing camps now begin to tap the touristic value of the region.

GENERAL GEOLOGY

The area covers approximately one quarter of the portion of the Labrador trough that is situated within the Province of Quebec. An area of Archaean gneisses named the Ashuanipi Complex bounds the Labrador trough in the west. The eastern boundary of the trough is marked by an anticlinorium where Archaean gneisses re-appear at the surface in the core of large domical structures. They underwent a second, Hudsonian, metamorphism and acquired a new texture, and mineralogy and were therefore named Wheeler Complex.

Early Proterozoic sedimentary, volcanic, and intrusive rocks of the Labrador trough sequence (Kaniapiskau Supergroup) (table 1) overlie the Archaean basement. The oldest Proterozoic rocks (Chakonipau Formation) were deposited in a continental fault basin. The continental red beds grade upwards into a marine ortho-quartzite-dolomite suite (upper Formations of the Pistolet Subgroup, Swampy Bay Subgroup). The rocks of this suite were deposited in a shallow marine basin. They are derived from source areas extending west and east of the trough.

Somewhat later a geanticline emerged in the centre of the depositional basin, and shale and greywackes of the Swampy Bay Subgroup were deposited in two separated basins in the west and east of the trough. Shortly afterwards the eastern and central parts of the geosyncline, including the central geanticline began to subside rapidly. Very great volumes of volcanic material erupted in the east of the geosyncline, whereas deposition of shales and greywackes continued in the west. This phase comprises the Bacchus Lake Formation and other parts of the Attikamagen. Finally basin subsidence decreased and more normal shaly dolomitic beds (Lac le Fer Formation, Denault Dolomite, Dolly Lake Formation) were deposited. A period of emersion at the basin margins followed and the sea gradually retreated towards the south.

A second suite of orthoquartzites and of chemical sediments (Ferriman Subgroup) overlies the older rocks with a profound marginal unconformity. It is overlain by slates and greywackes that interfinger in the east of the trough with basic volcanic rocks(Menihek Formation). Deposition of the main volcanic suite (Doublet Group) in the extreme east of the trough followed, and is interrupted by a period of sedimentation of shale and locally of iron formation (Thompson Lake Formation).

All rocks of the Labrador trough were folded, faulted and metamorphosed during the Hudsonian Orogeny. Trends of folds and of overthrusts are generally to the north-northwest, except in the segment between 56°00' and 56°30'. Syn-sedimentary faulting in this zone brought blocks of strongly differing mechanical properties in contact; the orogenic stresses, acting at a right angle to the geosyncline were refracted at the blocks boundaries, which resulted in complex folds and anomalous fold directions in the segment between 56°00' and 56°30'. The intensity of folding and of the metamorphism increases from west to east across the trough.

Small stocks of pegmatite and of granite intruded the terrain east of the Labrador trough shortly after the folding.

Few traces of the subsequent history of the region remain. The folded Labrador trough rocks are overlain by the Sims quartzite (Fahrig, 1967) south of the area, deposited more than 1450 m.y. ago. They have been intruded by late diabase dykes and are intersected by dykes and diatremes of kimberlitic-carbonatitic volcanoes of unknown age. It is probable that the region was once overlain by a thin cover of older Paleozoic rocks. These must have been eroded before Cretaceous time. Cretaceous clays and rubble iron ores remain in the Schefferville region (Gross, 1968) and prove that the area was continental at that time. The traces of cretaceous rocks have been removed elsewhere by glacial erosion during the Pleistocene.

STRATIGRAPHIC GEOLOGY

The earliest stratigraphical work in the area was done by geologists of Labrador Mining and Exploration Company close to

Schefferville. Geologists of the Geological Survey of Canada (Harrison 1952, Frarey 1971, Baragar 1967, Frarey and Duffell 1964, Harrison et al., 1972.) defined and formalized the stratigraphy the Schefferville section and extended it north toward 56°00'.

The writer established the stratigraphical sequence in the section north of 56°00' between 1963 and 1967, and carried it southwards between 1968 and 1970. Some minor revision of the stratigraphic terminology south of 56°00' will be proposed and some units will be subdivided. With these few exceptions the writer follows the stratigraphic nomenclature south of 56°00' as proposed by earlier workers. Changes in terminology will be kept to a minimum, and only few new formational names will be introduced. Formational names and dominant lithologies are specified on table 1.

ARCHAEAN

A complex of granitoid gneisses and granites underlies the Kaniapiskau rocks in the west and in the east of the Labrador trough. The basement complex west of the Labrador trough has not been involved in the Hudsonian Orogeny. It gives K/A ages (between 2,400 and 2,500 m.y.) characteristic of the Kenoran orogeny (Wanless, 1969). The migmatization of this terrain therefore occurred during the Kenoran Orogeny. Harrison (1952) introduced the name Ashuanipi Complex for the basement west of the trough.

The basement complex east of the trough, on the other hand, has been involved in the Hudsonian folding and metamorphism, and therefore yields Hudsonian K/A ages. It has the same overall composition as the basement complex in the west of the trough. The gneisses, however, acquired a new texture, and in part a new mineralogy during the Hudsonian Orogeny. The basement complex east of the trough that suffered a second deformation and metamorphism during the Hudsonian Orogeny was named Wheeler Complex (Dimroth 1969).

The Archaean age of the Wheeler Complex is not undisputed. De Roemer (1956) and Taylor (1968, 1969) suggested that the rocks of the Wheeler Complex are but highly metamorphosed equivalents of the Kaniapiskau Supergroup. This hypothesis is untenable, because it is irreconciliable with three independent lines of evidence:

1. The gneisses of the Wheeler Complex underlie domical anticlines mantled by schists and gneisses that are physically continuous with Proterozoic rocks. The Wheeler Complex is stratigraphically below its Proterozoic mantle. Such anticlines are present east of Wheeler river in the area described here, in the Thévénet Lake area (Gélinas 1965), and in the Ossokmanuan Lake area (Wynne-Edwards 1961). Conglomerates that incorporate gneiss pebbles are not uncommon in the lowermost Proterozoic rocks.
2. The migmatites of the Wheeler Complex suffered a retrograde metamorphism that is superposed on, and therefore younger than, their migmatization. The retrograde metamorphism of the Wheeler Complex

correlates with the progressive metamorphism of its Proterozoic cover. It follows that the migmatization of the Wheeler Complex is Pre-Hudsonian.

3. Granitoid gneisses from domes in the Thévénet Lake area gave Rb/Sr ages between 2,100 and 2,700 million years (Beall et al. 1963). The average (2,400 m.y.) presumably dates their Pre-Hudsonian metamorphism. It is therefore concluded that the granitoid gneisses formed during the Kenoran Orogeny.

Taylor (1969) furthermore obtained a K-Ar age of 2,150 m.y. east of the area, and a K-Ar ages of 1,915 m.y. has been obtained in the Fort Chimo region. These minimum ages for the basement rocks contrast with a Rb/Sr isochron of about 1,870 m.y. that dates deposition of the Sokoman Formation in the Schefferville area (Fryer 1971).

The stratigraphy of both gneiss complexes is outlined in table 2. The stratigraphy of the Ashuanipi complex is modified from Eade (1966), and Baragar (1967), and the stratigraphy of the Wheeler Complex is described after the present work in the Wheeler dome. The bulk of both gneiss complexes consists of acidic and intermediate gneisses and of amphibolites in various stages of granitization. A few granite massifs, and dykes of granite, granite porphyr, pegmatite, and of gabbro occupy less than 10 per cent of the surface of the Archaean complexes. Common characteristics of the Archaean rocks are the total lack of aluminous, calcareous,quartzitic, and graphitic rocks; these, on the other hand, form characteristic intercalations in the gneiss suites derived from the Aphebian sequence.

Table 2

Archaean Stratigraphy

Ashuanipi Complex	Wheeler Complex
Sharp angular unconformity with Aphebian rocks	Contact with Aphebian rocks sharp, no visible unconformity
dyke rocks: pegmatite, granite, granite porphyr, gabbro, diabase	pegmatitic gneiss
intrusive massifs: granite, porphyritic granite	
intrusive contacts	
granite gneiss monzonite gneiss granodioritic gneiss	granite gneiss granodioritic gneiss
gradational contacts	gradational contacts
homogenized biotite-amphibole gneiss and pyroxene gneiss granodioritic garnet gneiss	homogenized biotite-amphibole gneiss
gradational contacts	gradational contacts
amphibolite layered amphibole-biotite gneiss layered pyroxene gneiss	amphibolite layered amphibole-biotite gneiss

ASHUANIPI COMPLEX

The writer studied only few outcrops of the Ashuanipi Complex in the field; the following descriptions are therefore partly based on observations of glacial blocks, and on the descriptions by Eade (1966) and Baragar (1967).

Layered amphibolite-biotite gneisses are relatively uncommon in the area north of 55°45', but appear to play a somewhat greater role south of that latitude. They are composed of alternating, more or less sharply bounded dark and light layers about 1 inch across. Dark layers are biotite-schist, biotite-amphibole schist or amphibolite, and may contain 20-60 per cent mafic minerals (biotite, ± hornblende, ± diopside), 30-50 per cent oligoclase or andesine, and 5-30 per cent quartz. Light layers have a granitic or granodioritic composition (30-50 per cent oligoclase, 5-30 per cent microcline, 20-50 per cent quartz, some per cent biotite and/or hornblende). Layers, boudins, and lenses of amphibolite are common; they are generally one or a few feet thick. Occasionally amphibolitic zones are mappable. The gneiss is interwoven with a network of pegmatitic and granitic veins. Grain sizes of the dark layers are around 1 mm., and of the light layers around 2 mm.; textures are granoblastic.

The layered gneisses grade along and across the trend into homogenized biotite-amphibole gneisses that are by far the predominating rock type of the Ashuanipi Complex. The homogenized gneisses are composed of unsharply bounded discontinuous layers, schlieren, lenses and boudins of mafic material that are set in a generally granitic or granodioritic groundmass. Lenses, layers, and boudins of amphibolite are quite common, and may be concentrated in mappable zones. Vaguely bounded patches and veins of pegmatitic material compose some 10 per cent of the rock. Essentially the composition and structures of the homogenized gneisses are similar to those of the layered gneiss, except that the layers and lenses are less regular, and vaguely bounded; grain sizes are somewhat above those of the layered gneiss (dark layers 1-2 mm.; light layers 2-5 mm).

The homogenized biotite-amphibole gneisses grade imperceptibly into grey granodioritic, monzonitic and granitic gneisses that are the end products of the homogenization process. They commonly still contain vague schlieren and very unsharply bounded inclusions of biotite rich and amphibole rich material, as well as unsharply bounded amphibolite inclusions and ghost-like remnants of pegmatitic veins. Foliation is absent or at least very poorly developed. Grain sizes are between 2 and 5 mm.; textures are granoblastic. Granodioritic varieties, containing less than 10 per cent microcline, predominate by far. Thin layers of granitic gneiss are relatively common, whereas large bodies appear to be exceptional.

The gneisses observed by the writer, described above suffered amphibolite facies metamorphism, and contain biotite, amphibole and diopside as typical mafic minerals. Granulite facies rocks, characterized by the minerals hypersthene and diopside as mafics, have been described by Baragar (1968) and by Eade (1966). They appear to have the same structural and textural properties as the amphibolite facies gneisses.

Blocks of a granodioritic garnet gneiss observed west of Castignon Lake, and probably derived from the area southwest of Cambrian Lake, probably also belong into the granulite facies. This rock contains round garnet porphyroblasts 5-10 mm. across, set in a medium or coarse-grained quartzofeldspathic groundmass. It contains ghost-like remnants of pegmatitic veins.

A massif of coarse-grained pink porphyritic granite underlies the country west of Hematite Lake, and appears to continue for at least 10 miles to the west and southwest. It contains 10 per cent tabular microcline phenocrysts 3-5 cm. across. The phenocrysts are set in a coarse-grained (5-10 mm.) groundmass composed 10-15% tabular biotite, 25-30 per cent subidiomorphic plagioclase, 25-30 per cent xenomorphic microcline and 30 per cent xenomorphic quartz. Apatite and zircon are the accessories.

Dykes of a grey granite porphyr intersect the granite. They are composed of tabular perthitic microcline (1-2 cm. long) and plagioclase with resorbed, rounded edges, set in a equigranular panxenomorphic groundmass of microcline, quartz and albite. Dykes of pink fine-grained granite were described by Eade to intersect the gneisses with sharp contacts. The writer observed a gabbro dyke northwest of Helluva Lake. The gabbro is composed of clinopyroxene, hornblende, labradorite and some quartz. Actinolite, chlorite and sericite are alteration products.

Origin: It is likely that the gneisses of the Ashuanipi Complex are derived from a sequence of subaluminous sediments (greywackes, silty shales) and intermediate and basic volcanic and intrusive rocks, lacking mature quartzites, calcareous rocks, and aluminous shales. Anatexis (partial melting) of such a rock suite without substantial addition of new material from deeper zones could produce the layered gneiss suite. The homogenized gneisses could be produced by diffusive homogenization if the anatectic conditions are maintained for a very long time. Deformation of the partially molten rock would probably accelerate the homogenization. Small concordant bodies of granite gneiss could conceivably be derived from acidic volcanics, or could develop as mobilisates. The Archaean sedimentary-volcanic assemblages have a very low K_2O/Na_2O ratio (Baragar and Goodwin, 1968); large bodies of granite gneiss could therefore not develop through their anatexis without addition of K_2O from the outside. They could, on the other hand, develop by anatectic remobilization of older granites that were intrusive into the sedimentary-volcanic assemblage.

The strong local variability of the strike and dip of layering in the gneisses suggest that the rocks were complexly deformed before and/or during their anatexis. The coarsely granoblastic textures and the visible absence of strain in quartz and feldspar indicate complete post-kinematic recrystallization, and prove that anatectic conditions were maintained until the deformation had come to a complete end. The granite massifs intruded after the gneisses had been completely consolidated.

Finally granite and gabbro dykes intruded the gneisses as the last act of the Kenoran Orogeny.

WHEELER COMPLEX

The name Wheeler Complex is derived from Wheeler River, where a wide variety of Archaean gneisses underlie a large mantled gneiss dome, and where their stratigraphic position below the Proterozoic rocks has been ascertained beyond doubt. The Archaean gneisses of the Wheeler Complex are essentially identical to those of the Ashuanipi Complex, but underwent a second deformation and a retrograde metamorphism due to the Hudsonian deformation. The Hudsonian deformation leads to granulation and shearing of the Archaean gneisses, and the retrograde metamorphism to the growth of new minerals of the greenschist or low amphibolite facies. The Wheeler gneisses are consequently met in various stages of preservation.

The following descriptions are based on the rocks observed in the gneiss domes east of Wheeler river. Similar rocks form a nearly continuous belt of gneiss domes east of the Labrador trough and also occur in a few gneiss domes within the Labrador trough.

Most of Wheeler dome is underlain by a biotite-amphibole gneiss suite that shows only moderate traces of retrograde metamorphism. Extremely sheared gneisses in some zones in the southwest of Wheeler dome have been converted to sericite-biotite gneisses. The Archaean rocks in the extreme northeast corner of the Wheeler River Sheet (outside Wheeler dome) have been totally remetamorphosed in the low amphibolite facies and belong to a muscovite-biotite-plagioclase gneiss suite.

Biotite-amphibole gneiss suite

Biotite-amphibole gneiss, amphibolite, and pegmatitic gneiss compose the biotite-amphibole gneiss suite of Wheeler dome.

The bulk of this suite of rocks consists of medium-grained grey blastomylonitic biotite-amphibole gneisses with 1" to 1' thick layers and lenses of black biotite schists, greenish black biotite-amphibole schists and green biotite-epidote schists, of pegmatitic gneisses, and less commonly of amphibolites.

The biotite-amphibole gneiss is grey to light grey, fine- to medium-grained, and indistinctly layered. Biotite, feldspar and quartz can be identified macroscopically. The surface is commonly mottled by red and green specks (red: iron oxides in cracks of quartz; green: epidote in feldspars). The schistosity is commonly at an angle to the layers, and may be very faint. A faint linear structure parallels the intersection between layers and schistosity.

The biotite and biotite-amphibole schists are dark grey to black and medium-grained. The feldspars are segregated into thin lenses. Green aggregates of epidote are commonly visible with a hand lens. The schistosity is usually well developed and is commonly at an angle to the layers. The texture is granular.

Biotite-amphibole gneisses and biotite amphibole schists consist of quartz, plagioclase, microcline, biotite, amphibole and epidote in varying proportions. Chlorite, tourmaline, muscovite, apatite, opaque minerals, and pseudomorphs of unknown origin (possibly pyroxene) are the usual accessory minerals.

Quartz and the feldspars show the typical mortar or augen textures of blastomylonitic rocks: Aggregates of several larger grains are set in a mortar of more or less polygonal granules. Commonly narrow stringers of small quartz and feldspar granules separate large subparallely oriented quartz or feldspar grains. These are obviously relicts of larger crystals. The quartz grains are slightly undulous, the feldspars occasionally bent.

The plagioclases (An_{25-30}) include some muscovite tables and numerous well recrystallized epidote crystals. The epidotes are strongly concentrated in the centres of the plagioclases. Microcline is commonly free of inclusions, except for a few muscovite tables.

Dark brown or olive brown biotite occurs as thin tables, as larger shreds, or occasionally as thick and well shaped tables. It is commonly intergrown with epidote and concentrated in the dark layers.

Dark blue green hornblende forms short nematoblastic crystals. It is full of numerous quartz inclusions.

Light green epidote, with high birefringence and a small extinction angle tends to form subidiomorphic prisms parallel (010).

Twins parallel (100) are common. The epidotes are commonly oriented with their 100 axis parallel to the (010) and (100) planes of plagioclase.

Chlorite occurs only in small quantity. Some tables and radiating aggregates of light blue green prochlorite fill interstices between amphiboles and biotites, and apparently replaced both. A few long hexagonal prisms of dark blue green tourmaline with numerous quartz inclusions in the centre are occasionally present. The pleochroism is from light reddish brown to dark blue green.

Thin tables of muscovite are commonly oriented parallel to (010) or (100) of the plagioclase, or are intergrown with biotite.

Round crystals of apatite are present in all sections. In some sections pseudomorphs of a subidiomorphic prismatic habit were observed. These are now an isotropic brown substance. In one case a large pseudomorph was coloured red by iron oxide and surrounded by a rim of epidote. The centre and cracks in the brown substance were filled by a colourless, isotropic material.

The feldspar-rich rocks show the typical granulated texture of blastomylonitic gneisses: aggregates of larger quartz and feldspar grains, commonly with nearly parallel orientation are set in a granulated matrix. These aggregates are relicts of larger crystals that were destroyed by shearing.

The formation of epidote and muscovite, especially in the centres of plagioclase suggest that these gneisses contained originally calcium rich plagioclase. The formation of epidote is a clear indication of a retrogressive metamorphism of the same mineral facies as the ascending metamorphism of the amphibolites west of Wheeler river. The granulation of the feldspars appears to be due to deformation during the retrograde metamorphism.

The biotite and amphibole-rich rocks are granoblastic, their feldspars appear to be undeformed and do not show traces of the blastomylonitization. This does not indicate that they are younger than the gneisses, because rocks rich in amphibole and biotite recrystallize readily; traces of the deformation have therefore been destroyed in these rocks, whereas they are still visible in the gneisses.

A few larger bodies of amphibolite participate in this suite of rocks and were mapped separately. They are microscopically similar to the amphibolitic layers in the biotite-(amphibole) gneiss described above.

Several inches to half a mile thick lenses of a light grey medium grained pegmatitic gneiss occur within the biotite-amphibole gneisses. One large lense of this rock has been mapped separately.

The rock consists of quartz, oligoclase and microcline. The feldspars are strongly deformed, their twin lamellae bent. Plagioclase is somewhat muscovitized. A little epidote is present in the plagioclase. These rocks underwent the same metamorphism than the biotite-amphibole gneisses described above.

Biotite-muscovite gneiss suite

The southern portion of the gneiss area is underlain by a series of biotite-muscovite gneisses and augen-gneisses, sericite-biotite-chlorite gneisses and augen-gneisses, with subordinate dark grey quartzitic gneisses, and chlorite bearing amphibolites.

The typical muscovite and sericite bearing gneisses are dark grey and greenish grey fine-grained mylonitic rocks. Augen-gneisses with some relicts of larger feldspar are common. Layering is not well preserved. A schistosity, or several schistosities and linear structures are commonly present but are not easily measured, and are poorly defined. The grey quartzitic gneisses are the same as described above. Pegmatitic gneisses, similar to those described above, but more strongly sheared, occur as lenses within the sequence.

Plagioclase, microcline, quartz, muscovite, biotite, chlorite and epidote are the main constituents of these rocks. Calcite, apatite and opaque minerals are common accessory minerals.

Feldspar porphyroblasts are commonly deformed and consist now of several, slightly disoriented portions. The feldspars, especially the plagioclases are full of epidote and sericite inclusions which may make up ½ of their mass. These porphyroblasts are set in a fine flaser of quartz and albite granules, sericite, and epidote. Quartz is in large, strongly undulous grains and as small undeformed polygonal granules. It commonly contains some inclusions of sericite and of epidote.

Corroded shreds and shapeless masses of dark olive green biotite are intergrown with muscovite and sericite. Pleochroic haloes around epidote are common in biotite. Thick flasers of muscovite surround quartz and feldspar lenses. Grains and clusters of grains of epidote are common in feldspars and in the sericitic matrix. The cores of the epidote grains are full of small inclusions and have a somewhat higher birefringence than the rims. Epidote is slightly pleochroic. A grass green prochlorite forms spherical aggregates and has partly been deformed. Ameboid grains of calcite are rare.

The retrograde metamorphism of these rocks is considerably stronger than that of the biotite-amphibole gneiss. The rocks are rich in epidote, and it is apparent that muscovite and epidote are derived from calcic plagioclase. This rock therefore is derived from the same high grade gneisses containing calcic plagioclase that is also source rock of the biotite-amphibole gneiss. The retrograde metamorphism occurred in the stability field of biotite. Amphibole did not form in these rocks, and feldspar has been partly sericitized.

<u>Biotite-muscovite-plagioclase gneiss suite</u>

Light grey, medium-grained biotite-muscovite-plagioclase gneisses represent parts of the Archaean basement in the extreme northeast of the Wheeler river map area. The rocks underwent extremely strong Hudsonian deformation that destroyed most of the textural properties inherited from the Kenoran Orogeny. They grade into the normal biotite-amphibole gneisses, in less deformed zones, particularly towards the northeast.

The biotite-muscovite-plagioclase gneiss has a granodioritic composition. It is faintly layered due to slight variation of mafic contents. Deformed pegmatoid veins constitute about 10-20% of the rock. The gneiss is composed of quartz (10-30%), oligoclase (30-50%), microcline (5-20%), biotite (5-15%), muscovite (5-20%), minor amphibole and epidote and accessory zircon and apatite. Quartz and the feldspars are granoblastic. Biotite and muscovite are well oriented parallel to a folded cleavage (S_1), and locally parallel to a cleavage (S_2) that forms the axial planes of S_1 folds. Both minerals are locally flexured.

The biotite-muscovite-plagioclase gneiss forms a monotonous gneiss series that underlies a series of heterogeneous biotite-plagioclase paragneisses with layers of quartzites, calc-silicate rocks, amphibolites and ultrabasic rocks of Proterozoic age in the extreme NE of the area. Hand specimen of the biotite-muscovite-plagioclase gneiss are commonly indistinguishable from some Proterozoic gneisses of a meta-siltstone derivation. However the Archean sequence is clearly differentiated from the Proterozoic sequence by the following properties:

The Archaean sequence is of monotonous granodioritic composition; it is indistinctly layered and contains many deformed pegmatoids. Archaean biotite-muscovite-plagioclase gneiss grades into blastomylonitic migmatites. The Proterozoic suite, on the other hand, is well layered on a metre to dekametre scale. Proterozoic gneisses generally exhibit relict bedding. They are on the whole more mafic. Proterozoic gneisses in this zone are devoid of pegmatoid veins, and pegmatitic stocks in it are undeformed. It is not migmatized, and not blastomylonitic. The Proterozoic suite finally contains beds, between 1 and 20 metres thick, of quartzite, calc-silicate rocks, marbles, amphibolites and ultramafics.

Stratigraphic relations

Wheeler Dome is mantled by arkoses, and arkosic conglomerates of the Milamar Formation. The contact between both units is exposed east of Wheeler river, at lat. $56^{o}17'$, long. $67^{o}32'$ and farther southeast. This contact and the shapes of the contact leave no doubt that the contact between the gneisses is unfaulted and that the gneisses of the Wheeler dome underlie the Proterozoic cover rocks. The arguments proving an Archaean age of the rocks of the Wheeler Complex have been discussed above.

Origin

The gneisses of the Wheeler Dome are manifestly polymetamorphic rocks. In the earlier recognizable phase of metamorphism they were converted to more or less homogenized granitized gneisses, that are totally analogous to those of the Ashuanipi Complex. Later they underwent a retrograde metamorphism. The mineral facies of their retrograde metamorphism varies, from the biotite-albite subfacies of the greenschist facies at Wheeler River to the sillimanite-muscovite subfacies of the amphibolite facies in the northeast of the Effiat Lake area. The retrograde metamorphism is syn- to post-kinematic to a deformation that affected the basement gneisses as well as the overlying Proterozoic rocks. Mineral facies boundaries of the retrograde metamorphism in the Wheeler Complex are continuous with the mineral facies boundaries of the prograde metamorphism in their cover rocks. It follows that the retrograde metamorphism took place during the Hudsonian orogeny.

PROTEROZOIC

All the Proterozoic rocks of the area belong into the Kaniapiskau Supergroup. They represent a relatively short period of the Proterozoic: they are younger than diabase dikes intrusive into the Superior farther north (Fahrig and Wanless 1963, 2150 m.y.) and older than the Hudsonian Orogeny (1610 m.y., Dimroth 1970b). A Rb-Sr isochron age of 1879 ± 43 m.y. has been obtained from shales above and below the Sokoman Formation and probably dates their deposition (Fryer, 1971). Their deposition therefore took place during the younger Aphebian Era. The Proterozoic rocks are subdivided as follows.

Table 3. Subdivisions of the Proterozoic in the Central Labrador trough

<table>
<tr><td colspan="5">Sims Formation (older than 1400 m.y.)</td></tr>
<tr><td colspan="5">Folding (approximately 1610 m.y.) and profound unconformity</td></tr>
<tr><td rowspan="5">KANIAPISKAU SUPERGROUP</td><td colspan="2">Doublet group
(mostly basaltic rocks)</td><td colspan="2">Montagnais group
(gabbros and ultrabasic rocks)</td></tr>
<tr><td rowspan="4">KNOB LAKE GROUP</td><td rowspan="4">SEDIMENTARY ROCKS</td><td>Ferriman Sub-group
(app. 1879 m.y.)</td><td rowspan="4"></td></tr>
<tr><td>Swampy Bay Subgroup and Attikamagen Sub-group</td></tr>
<tr><td>Pistolet Sub-group</td></tr>
<tr><td>Seward Sub-group
(< 2150 m.y.?)</td></tr>
</table>

KNOB LAKE GROUP

The Knob lake group, defined by Harrison (1952) and Frarey and Duffell (1963), comprises all predominantly sedimentary formations of the Labrador Trough, which are stratigraphically below the volcanic Doublet group. Rocks equivalent to the Knob Lake Group overlie diabase dykes dated at 2150 m.y. (Fahrig and Wanless, 1964), in the northern most Labrador trough. Ages of 1650-1600 m.y. (Wanless, 1969) date their deformation.

SEWARD SUBGROUP

The name Seward was first introduced for a unit of formational rank by Frarey and Duffell (1964) in the southern Labrador trough. Baragar (1967) traced the unit northward to lat. 56°00'N. The writer (1968b, 1969) subdivided it into four sub-units of formational rank and elevated the Seward to subgroup status. The Seward comprises predominantly continental red arkoses, grits, conglomerates and sandstones; red or pink calcarenites and dolomites are in part intercalated between the arenitic rocks and are in part their lateral facies equivalent. The Seward overlies the Archaean basement, and is overlain by the marine shales and siltstones of the Lace lake Formation.

The Seward has been subdivided into four formations in the north of the region:

1. The Chakonipau Formation: red arkose, grit, conglomerate
2. The du Portage Formation: red arkosic sandstone with intercalated pink dolomite and dolomitic sandstone
3. The Dunphy Formation: pink dolomite with intercalated fine-grained sandstone or siltstone
4. The Milamar Formation, formally introduced in this report: metaarkose, metaquartzite, metaconglomerate with intercalated dolomite beds.

The writers field work in the zone south of 56°00' has not been sufficiently detailed to permit consistent mapping of the subdivisions of the Seward. Lithological equivalents of the Dunphy Dolomite are known as far south as 55°45', and equivalents of the du Portage and Chakonipau Formations were recognized at a great number of localities throughout the map area. The lithological subdivisions of the Seward and the facies relationships within it are most readily shown on table 4.

CHAKONIPAU FORMATION

The term Chakonipau Formation (Dimroth 1969) has been proposed for a sequence of red arkoses and arkosic conglomerates typically exposed at Castignon and Chakonipau lakes. The type locality is at lat. 56°17', long. 68°25' east of Chakonipau lake.

Table 4: Representative stratigraphic sections across the Seward Subgroup

	Lace Lake	du Portage Lake	Cramolet Lake	Dunphy Lake
	Lace Lake Formation	Lace Lake Formation	Bacchus Formation UNCONFORMITY	Lace Lake Formation
DU PORTAGE FORMATION	poorly exposed: red very fine-grained arkosic sandstone much red, medium- to coarse-grained dolomitic sandstone and calcarenite one or two 30 feet beds of pink stromatolitic dolomite	red very fine-grained arkosic sandstone. Some 10 feet interbeds of pink, medium-grained arkosic sandstone and quartzite. Three 30 feet beds of coarse-grained pink dolomitic sandstone, calcarenite, and stromatolitic dolomite	poorly exposed: red very fine-grained red sandstone, pink medium- to coarse-grained dolomitic sandstone 30 feet beds of pink, brown weathering dolomite	DUNPHY FORMATION: pink stromatolitic dolomite with 1 inch-6 feet interbeds of red very fine-grained arcosic sandstone
			poorly exposed: green siltstone and argillite with 1 foot thick lenses of brown weathering dolomite	grey laminated argillite, siltstone and shale
	UNCONFORMITY	gradational contact		
CHAKONIPAU FM.	not deposited or eroded before du Portage deposition	arkose, arkosic grit and conglomerate. See sections table 5	South of Cramolet Lake: pink arkose, pink arkosic grit and pebble conglomerate. Basaltic agglomerate, basalt tuff, basalt lava	CHAKONIPAU FM.: pink arkose, arkosic grit and arkosic pebble conglomerate
		base not exposed	base not exposed	base not exposed
	ARCHAEAN (Ashuanipi Complex)			

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West of Romanet Lake	Romanet river (E. end)	Milamar Lake		
Lace Lake Formation	Lace Lake Formation		Lace Lake Formation	overlying rock
pink stromatolitic dolomite with 1 inch - 6 feet interbeds of purple or green siltstone. Locally ankeritized, then yellow, brown weathering	brown weathering ankeritized dolomite with 1 foot to 6 feet thick interbeds of brown weathering, coarse-grained dolomitic sandstone	MILAMAR FORMATION	metaarkose, meta-conglomerate, metaquartzite lenses and layers of dolomite marble at top	UPPER SEWARD (DU PORTAGE AND DUNPHY FORMATIONS)
grey laminated silt-stone and shale with 1 foot lenses of grey, brown weathe-ring dolomite. Beds of green laminated siltstone	white, laminated quartzite, grey laminated argillite		UNCONFORMITY	
white, green, or pink arkose, arkosic grit or pebble con-glomerate base not exposed	white, sheared, coarse-grained arkose base not exposed			LOWER SEWARD (CHAKONIPAU FM.)
			ARCHAEAN (Wheeler Complex)	underlying rock

The typically developed Chakonipau underlies most of the Chakonipau lake basin, and extends toward Otelnuk lake in the northern portion of the area. Red beds, lithologically similar to portions of the Chakonipau, but containing some calcareous material, continue east and southeast of Otelnuk lake and trend into the Wakuach Lake area farther southeast. Boulders of a pink, well bedded arkosic sandstone, doubtless of local origin occur on the islands within Dunphy lake. A sequence of arkose and arkosic pebble conglomerates, devoid of calcareous beds, is at the base of the Labrador Trough sequence north of Ronsin lake (Romanet Lake area). A formation of arkosic sandstones underlies the area north of Luche lake (Castignon lake area) from where it extends to the west of Cambrien lake. We regard all these rocks provisionally as equivalents of the Chakonipau Formation. Equivalents of the Chakonipau underlie wide areas at Ribeiro, Musset, Billiard and Sanderson Lakes south of 56°00'.

The Chakonipau commonly underlies somewhat higher ground than adjoining slates or shales, and lower or higher ground than adjoining dolomite and limestone. There are no particularly resistant horizons in the formation and its topographic relief is therefore subdued. Bedding is commonly brought into relief by shallow valleys and ridges even where outcrop is rare.

Chakonipau lake basin

The type section through the Chakonipau Formation is shown on table 5. Two other good sections through the formation are exposed at Du Prospecteur lake and east of Chakonipau lake at lat. 56°13'. At all three localities the formation can be subdivided into three members as follows:

1. A lower member composed of very fine-grained dark red arkose.
2. Member 2 consisting of very coarse boulder conglomerate with local interbeds of pebble conglomerate, arkose, and very fine-grained arkose.
3. Member 3 consisting of alternating beds of arkose, and pebble conglomerate. Calcarenites and a few local dolomite beds occur at the highest stratigraphic level.

The grain size of the boulder conglomerates decreases rapidly to the north, which prohibits distinction of members 2 and 3 north of lat. 56°18'.

Petrography

The very fine-grained arkose is a dark red, well indurated hard rock. It is bedded on a cm scale, and shows commonly crossbedding. It consists of 35-40% quartz, 50% plagioclase and a few andesite splinters of up to 0.4 mm. set in a hematite rich clay matrix. Clastic grains of

Table 5 <u>Typical Sections of the Chakonipau Formation</u>

	Du Prospecteur lake		E-shore of Chakonipau lake, lat. 56°17' (type section)		E-shore of Chakonipau lake, lat. 56°12'
1000' 1000' 300'	m) medium-grained pink arkose, pebble conglomerate, some dark red very fine-grained sandstone l) medium-grained pink arkose k) same as m) i) same as l) h) dark red very fine-grained arkose	300' 900' 800'	e) medium-grained pink arkose d) pebble conglomerate interbedded with arkose as in and with a little dark red very fine-grained arkose c) medium-grained arkose	1800'	c) pink arkose, pebble conglomerate and dark red very fine-grained arkose. Some pink calcarenite in highest levels.
1200' 400'	g) pebble and boulder conglomerate f) same as h) (local) e) same as g) d) same as h) (local) c) same as g) b) same as m)	700'	b) pebble and boulder conglomerate	500'	b) boulder conglomerate
600'	a) same as h)	500'	a) dark red fine-grained arkose, commonly with white spots	700'	a) dark red very fine-grained arkose
	base unknown		base unknown		base unknown

magnetite and tourmaline were observed. The plagioclase is little sericitized. A few of the plagioclases seem to be derived from the andesite and contain characteristic magnetite inclusions. A few quartz grains are intergrown with plagioclase or contain biotite inclusions and are derived from a coarse-grained plagioclase-biotite gneiss. The arkose is strongly compacted, and not more than 10 per cent of a dark red hematite bearing clay matrix cements the clastic grains.

The conglomerate contains ca 30-65% pebbles and/or boulders of biotite-plagioclase gneiss and of andesite. The pebbles are set in an arkose matrix composed of quartz, plagioclase and very little microcline. Clastic biotite is rare. Some fragments of micropegmatite were observed. Plagioclase is slightly sericitized. The sand grains have a diameter of up to several millimeters. The rock is strongly compacted. Less than 10% cement, quartz, more commonly a hematite-clay matrix, or sericite, bound the fragments. The conglomerates are irregularly interbedded with medium- or coarse-grained arkoses and with very fine-grained arkoses, and are commonly crossbedded.

The larger fragments of the conglomerates are up to 2 feet in diameter in the boulder conglomerates, and have diameters of up to 2 inches in the pebble conglomerates. The fragments, especially those of andesite, are not well rounded. The gneiss fragments partly disintegrated before or during the compaction of the rock. Andesite fragments occasionally have a red, hematite rich weathering crust at one side. The gneiss fragments of the conglomerates are homogeneous and consist of ca 50% feldspar (mainly plagioclase), 45% quartz, and 5% biotite. The biotite is commonly replaced by hematite, except as inclusion in quartz or feldspar. The texture is granoblastic. The grain size is between 1 and 5 mm. The andesites consist of plagioclase laths with some interstitial opaque minerals (probably pyroxene or biotite replaced by hematite), and a little interstitial quartz. Biotite is rarely preserved. The texture is intersertal. The grain size varies from 0.02 mm to ca 2 mm.

The medium- and coarse-grained arkoses are pink or salmon coloured. Their grains sizes are below 5 mm and they consist of 30-35% clastic quartz, 35-40% plagioclase, ca 1% clastic magnetite embedded in ca 15% sericite matrix. A few gneiss pebbles are present; pebbles of the andesite are less common and seem to be absent at higher stratigraphic levels. The plagioclases of the arkose of member 3 are much more sericitized than those of the members 1 and 2, and their sand grains are better rounded.

A dolomitic sandstone observed in the highest stratigraphic levels of the member 3 consists of ca 70% clastic grains (quartz with outgrows, little plagioclase) set in a matrix of calcite and chert. The few plagioclase are strongly sericitized. Beds of this rock alternate with beds of calcarenite composed of ca 50-60% clastic grains (quartz, calcsandstone containing quartz splinters, and rare plagioclase) set in a calcite matrix. Both rock types are relatively loosely packed.

Area east of Otelnuk lake

Medium-grained, salmon colored sandstone, red and pink arkose and a little fine-grained conglomerate are poorly exposed northeast of Otelnuk lake. A sequence of red, medium- to coarse-grained, commonly arkosic sandstones, arkoses, and pebble conglomerates, with beds of pink or salmon, commonly stromatolitic limestones and of calcarenites is present south of d'Argencourt Bay. This sequence is intruded by thick gabbro sills. Lack of outcrop prohibits further subdivision. The lithological character of this sequence is similar to the upper member of the Chakonipau Formation. Equivalents of the du Portage Formation are likely present.

The red beds are contact metamorphic in an approximately 50 foot wide zone above and below the gabbro sills. The sandstones have been converted to white quartzites and commonly bear epidote veins parallel to the bedding in a 5-10 foot zone at the contact. Calcareous rocks were altered to talcose schists.

Boulders of well-bedded pink arkosic sandstones occur on the islands in Dunphy lake (latitude 56°1', longitude 67°42'). These boulders are thought to be of local origin because of their large size (several cubic yards) and sharp-edged shape; they are lithologically similar to bedded arkosic sandstones exposed east of Otelnuk lake. The boulders occur in a NNE trending anticline below a major thrust fault.

Arkosic pebble conglomerates containing andesite pebbles were observed at d'Argencourt bay, but seem otherwise to be absent in the area east of Otelnuk lake.

Petrography

The arkoses of the Chakonipau east of Otelnuk lake are relatively poor in feldspar, and contain ca 50-60% quartz grains, 10-15% plagioclase, some microcline grains, small pebbles of gneiss and very rare chert fragments. The matrix consists of sericite, quartz, and commonly a few grains of calcite. The calcarenites in this member were not investigated in thin-section. Very coarse-grained calcilithites were observed at some localities. The stromatolithic limestones show a lamellar texture of finer and coarser grained calcite. They contain a few splinters of quartz silt (ca 3%) and a few rounded sand grains of up to 1 mm diameter.

Romanet lake area

Arkoses and conglomerates of the Chakônipau Formation occur east of du Chambon lake, northwest of Bertin lake and between Bertin and Romanet lakes in the Mistamisk and Romanet Lake areas. Quartz-sericite schists derived from arkoses underlie the northern portion of this zone, especially northwest and east of Bertin lake, and southwest of Duvic bay of Romanet lake. They formed at a major thrust fault. Schistose arkoses occuring on an island of Romanet river, and in the Romanet river zone at lat. 56°22', long. 67°46' were also correlated with the Chakonipau formation.

The arkose is a light greenish grey, locally light pink weathering, massive and well indurated rock. Beds are between 5 mm and 3 cm thick. Tabular bedding and cross-bedding were observed. Bedding planes are marked by gradation of grain size, by thin sericite films, or by dark grey magnetite bearing laminae 1 mm across. The rock is composed of clastic quartz and ca 25-40 per cent of clastic feldspar (mostly plagioclase, some microcline). Grain sizes vary from 0.5 to 2 mm. The rock is strongly compacted, and the grain boundaries sutured. Some sericite is present at the grain boundaries, and plagioclase is somewhat sericitized.

Sheared varieties of the arkose are exposed at Romanet river. They are schistose rocks composed of deformed quartz and feldspar fragments of 1 to 2 mm diametre set in a mylonitic sericite flaser parallel to the schistosity.

Quartz-albite-sericite schists derived from the arkose occur between Bertin and Romanet lakes. They are light grey fine-grained schistose rocks, composed of quartz, albite and sericite. The sericite flakes are oriented parallel to the schistosity. A fracture cleavage, parallel to the axial plane of small-scale folds, is commonly present.

The arkose grades continuously into arkosic conglomerate consisting of quartz pebbles of 4 cm maximum diameter set in an arkosic matrix with a grain size of less than 5 mm. The conglomerate is always weathered to a light pinkish brown. Bedding is not well developed.

Luche lake

A sequence of grey, green or pink arkoses and sandstones is exposed north of Luche lake in the Castignon lake area, and has been correlated with the Chakonipau Formation. The arkoses are medium-grained (1-2 mm). They are composed of quartz (60%), feldspar (30%, plagioclase, some microcline), set in a sericite groundmass. The rock is strongly compacted. The feldspars are commonly somewhat sericitized and feldspar and quartz are underwent some recrystallization. The rocks are commonly well bedded;

cross-bedding is rare. Quartz sandstones, with well rounded quartz grains are common in this area.

Area south of 56°00' N.

Rocks of the Chakonipau Formation underlie large areas south of 56°00'; they have not been separated from the overlying du Portage rocks in this area, and both were grouped as unsubdivided Seward on the accompanying maps. Generally they form the lower horizons in the anticlinal zones south of Ribeiro Lake, at lac Musset, Pickup Lake, Billiard Lake, Lac Messaiger, Lac Pellegrin and Sanderson Lake. The formation is represented by red or pink, medium-grained arkose and arkosic pebble conglomerates similar to the rocks described above. The formation contains a prominent volcanic member between Lac Musset and Persephone Lake.

The volcanics of the Chakonipau are grey to greenish grey massive, aphanitic lavas and green or red, mottled fragmental rocks. Bedding has not been observed. Agglomerates are composed of sandstone, siltstone and volcanic fragments of up to 15 cm diametre.

The volcanic rocks are strongly altered and are composed of minute feldspar, indeterminable because of its small grain size, but probably alkalic, chlorite, hornblende, and considerable finely distributed iron ore. Chemical analyses (table 6) of two samples of a massive volcanic are comparable to trachybasalts. They are highly oxidized lavas rich in alkalies, in particular in K_2O. The Chakonipau volcanics therefore appear to be very different from the ophiolites of the Labrador trough both in respect their geology (sub-aerial volcanics, associated with red-beds vs. marine volcanics associated with shales and greywackes), and in respect to their chemistry (high K_2O and high Fe_2O_3/FeO in Chakonipau rocks vs. very low K_2O and low Fe_2O_3/FeO in ophiolites).

Correlations and depositional environment

The Chakonipau Formation is at the base of the Kaniapiskau Supergroup in the type area, where it is overlain by rocks of the du Portage Formation. The contacts between both formations are exposed and the structure in the contact zone has been controlled by numerous determinations of sedimentary tops. The rocks correlated with the Chakonipau in the area east of Otelnuk Lake are in part similar to the upper member of the type locality. Other outcrops contain much stromatolitic dolomite and calcarenite, similar to those of the du Portage. Pebble conglomerates containing fragments of andesite were observed at a few localities, and such fragments are absent in the du Portage Formation. A few beds of dolomitic sandstone

Table 6

Volcanic rocks of the Chakoniapu Formation

	(1) 18-1-11	(2) 18-1-12
SiO_2	49.66	49.92
TiO_2	1.27	1.38
Al_2O_3	13.95	15.47
Fe_2O_3	11.16	7.87
FeO	3.08	5.33
MnO	0.21	0.22
MgO	3.98	3.42
CaO	4.21	2.79
Na_2O	4.90	4.80
K_2O	2.76	4.30
P_2O_5	0.13	0.14
H_2O+	2.40	1.96
H_2O-	0.06	0.06
CO_2	1.95	2.12
S	0.09	0.09

18-1-11, 18-1-12 trachybasalts of lac Musset.

Analysis: H. Boileau, Q.D.N.R.

and of stromatolitic dolomite do occur in the highest horizons of the Chakonipau Formation at the type locality, although they are not as abundant as in the area east of Otelnuk lake. It is therefore believed that the red arkoses, pebble conglomerates, calcirudites, calcarenites, and stromatolitic dolomites exposed east of Otelnuk lake correspond essentially to the upper member of the type Chakonipau but that they may include equivalents of the du Portage. The same stratigraphic position is indicated for the rocks correlated with the Chakonipau Formation underlying the basin of Dunphy lake.

The arkoses occurring in the du Chambon-Romanet lake zone are at the base of the Kaniapiskau Supergroup. They underlie the Dunphy dolomite, of which they are separated by a thin layer of shale. The stratigraphic relations are controlled by sedimentary tops and the contacts between the formations are exposed. The arkoses are associated with unquestionable equivalents of the Dunphy Formation in the Romanet river zone. Contacts are not exposed and no structural control exists. The correlation of these occurrences with the Chakonipau Formation, although very probable, is not unquestionable.

The same situation exists at Luche lake, where the arkoses overlie Archaean granites and are unconformably overlain by rocks of the Ferriman Subgroup. Their relations to the rocks of the Pistolet Subgroup, exposed south of Luche lake, are not clear. There can be little doubt that the arkoses are older than the Pistolet Subgroup. The arkoses trend to the west into the area west of Cambrian lake, where conglomerates similar to those of the type area have been described by Fahrig (1956b). The correlation of this occurrence with the type locality seems therefore to be well founded.

The Chakonipau type rocks are also at the base of the Proterozoic sequence in the area south of 56°00'. They grade upwards into lithological equivalents of the du Portage.

Depositional environment: Poor sorting and rounding, torrential cross-bedding, and particularly the presence of coarse fanglomeratic boulder conglomerates suggest that much of the Chakonipau was deposited by rapidly flowing seasonal torrents. Intense hematitization, and weathering crusts coating andesite fragments suggest strongly oxidizing conditions, and high rates of chemical weathering in a sub-aerial environment during transport and deposition. Rapid transport and rapid burial of the sediments is inferred from the lack of alteration of feldspar. Such conditions are most likely to exist in a rapidly subsiding continental fault basin under warm, semi-arid climatic conditions.

The Chakonipau rocks are derived from a terrane underlain by biotite-amphibole-plagioclase gneiss and subordinate granite. Volcanic fragments are likely derived from contemporaneous extrusions. Fragments of sediments and of low-grade metamorphic rocks are totally absent. The Chakonipau rocks are therefore clearly derived from the Ashuanipi Complex. Baragar (1967) deduced from cross-bedding measurements that the Chakonipau is derived from a terrane below the western part of the Labrador trough and was redistributed by basin parallel currents trending northwest and southeast. Dimroth (1968b) suggested that the boulder conglomerates south of Chakonipau lake area are derived from a fault scarp trending from Otelnuk Lake towards Cambrien Lake in the west. The volcanic activity during Chakonipau deposition is thought to be related to the contemporaneous faulting.

DU PORTAGE FORMATION

The du Portage Formation is characterized by the association of predominating very fine grained red arkosic sandstone with pink quartz-sandstone, pink dolomitic sandstone, calcarenite, and stromatolitic dolomite. The formation represents the western marginal facies of the Upper Seward division, and grades eastward into the predominantly dolomitic Dunphy Formation. Its lower boundary generally has to be defined arbitrarily, except in a few places in the centre of the Labrador trough, where a horizon of green siltstone separates the Chakonipau and du Portage Formations. The upper contact of the du Portage is gradational within a few tens of feet. The type locality is west of du Portage Lake, at lat. 56°19', long. 68°27'. The lower contact of the formation is exposed south of du Portage Lake, at lat. 56°17', long. 68°27', and the upper contact west of du Portage Lake, at lat. 56°21', long. 68°27'.

The lower boundary of the du Portage has been defined by the lowest dolomitic bed in the arenaceous sequence at the type locality. Approximately 200 feet of medium- to coarse-grained pink arkose with interbeds of fine-grained red arkosic sandstone follow upwards. These arkoses still have typical Chakonipau character; they should perhaps included in the Chakonipau, as similar rocks have been elsewhere. The main body of the formation is predominantly composed of bright red very fine-grained arkosic sandstone, with 10 feet thick interbeds of pink, medium-grained quartz sandstone. Three or four beds, each approximately 30 feet thick, of pink, brown weathering dolomitic sandstone and calcarenite, or of pink stromatolitic dolomite are characteristic members of the formation. Lateral facies gradation from dolomitic sandstone through calcarenite into dolomite is common; the dolomitic beds however are continuous over a distance in excess of several miles without substantial change of thickness. Some 20 or

30 feet of alternating very fine-grained red sandstone, green siltstone, and grey laminated argillite and slate are at the top of the formation. Some 10-30 feet beds of white or very light pink massive, recrystallized quartzite occur in the formation north and west of Castignon Lake.

The du Portage overlies the Archaean gneiss in the west of the Labrador trough between Pistolet and Lace Lakes. Outcrop in this zone is very poor and the resistant beds of dolomitic sandstone, calcarenite, and dolomite generally constitute the only exposure. Glacial blocks suggest that the very fine-grained red sandstone is also present.

The stratigraphic relations southeast of Otelnuk Lake are very unclear. Some beds of stromatolitic dolomite and of dolomitic sandstone occur in the arkosic sequence. Grey or green fine-grained impure quartzites were observed in contact with gabbro. These poorly exposed rocks have been included with the Chakonipau on the accompanying maps, but might be partly equivalent to the du Portage. The sequence underlies the Dunphy dolomite which is unusually thin at this locality.

The du Portage has been little studied south of

56°00'. Equivalents of the formation are present at Ribeiro and Cramolet Lake, at the top of the red bed sequence north of Musset Lake, at Sanderson Lake and Twisted Lake. The core of the anticlinorium between Lac Musset and Sanderson Lake appears to be underlain by equivalents of the Chakonipau Formation. Red beds that crop out in the core of a domical anticline south of Tait Lake also appear to belong to the du Portage Formation.

A unit of green siltstone with lenses of grey, brown weathering dolomite has been mapped at Cramolet Lake below equivalents of the du Portage. It is presumed that this member is equivalent to the basal member of the Dunphy Formation. It does not appear to be widely distributed.

Petrography: The alternation between very fine grained arkoses and medium to coarse grained quartz sandstones is a characteristic of the du Portage in the type area. Very fine grained arkoses do not appear to predominate anywhere south of 56°00', except at Ribeiro Lake. Elsewhere the formation is predominated by medium to coarse quartz-sandstones and sub-arkoses.

Very fine-grained arkosic sandstones are dark red thinly bedded rocks. Their grain size is around 0.05-0.1 mm. Quartz and about 20-40 per cent feldspar (plagioclase and microcline) are the clastic components. The fragments are sharp edged, angular, poorly rounded, but appear to have very good size sorting. The fragments are coated by hematite, and are densely compacted.

Pink, medium to coarse grained arkoses are common only at the base of the formation at the type locality. This part of the formation containing much arkose should perhaps be included with the Chakonipau. Their feldspar content decreases upwards. The arkoses have angular fragments and are strongly compacted.

Pink, medium- to coarse grained quartz sandstones and, less commonly, sub-arkoses are important higher up. Locally these rocks have been recrystallized to white massive, structureless orthoquartzites, that commonly have a very faint pink colour. Dolomitic sandstones, also pink, are very coarse grained (1-5 mm). Quartz is the only clastic component. Some dolomitic sandstones have extremely variable packing; some pockets are strongly compacted, whereas others are composed of nearly pure dolomite including a few clastic quartz grains. The dolomitic sandstones grade into calcarenites composed of pink calcareous intraclasts (1-20 mm long), of rare ooliths, of fragments of stromatolitic crusts, and some quartz grains cemented by dolomite. All the coarse-grained quartz sandstones are characterized by very well rounded quartz, in contrast to the fine-grained arkoses, which are composed of angular fragments.

The stromatolitic dolomites are identical to these of the Dunphy Formation. They grade laterally and vertically into calcarenites. The argillites at Cramolet Lake and at du Portage Lake are similar to argillites of the Lace Lake Formation and need not be described here.

Current crossbedding, ripple marks, and tabular laminations occur in all arenaceous rocks of the formation.

Stratigraphic position, correlation, and depositional environment

The lower and upper contacts of the du Portage Formation are exposed in the type area at localities where the structure has been controlled by sedimentary top determinations. There is therefore no doubt that the du Portage Formation overlies the Chakonipau Formation and underlies the Lace lake Formation in the type area. The contacts of the formation are not exposed in the de la Concession-Pistolet lake valley. The structures in this zone are simple, and many sedimentary top determinations are available. Therefore no doubt remains that the du Portage Formation overlies the Archaean gneisses and underlies the Lace lake Formation in this zone. Identical lithofacies, and homotaxial position of the du Portage Formation below the Lace lake Formation prove the correlation between the occurrences in the Castignon-Chakonipau lake basin, and in the de la Concession Lake-Pistolet lake zone.

Depositional environment: The facies of the du Portage suggests deposition in a continental - littoral transitional environment. Transport of some of the very fine-grained sandstone by wind has been inferred (Dimroth 1968a) from their good sorting, and fine¢grain combined with the poor rounding and high feldspar contents. Floating sand grains of the same size are common in the Dunphy Dolomite, and are also likely to be wind transported. The coarse grained dolomitic sandstones, and the quartz grains of the calcarenites, on the other hand are well rounded; these sandstones, and the stromatolitic dolomites are presumably shallow marine sediments.

DUNPHY FORMATION

A thick unit of pink stromatolitic dolomite forms the top of the Seward subgroup in the center of the Labrador trough, and has been named Dunphy Formation (Dimroth, 1969). The unit has originally defined at Dunphy River, just east of Otelnuk Lake (lat. 56°07', long. 68°00'). Neither base nor top of the formation are exposed at the type locality. A much better section has been discovered later between Ronsin and Romanet Lakes (lat. 56°17' N., long. 67°50' W.). This section is vertically continuous; furthermore the base and the top of the formation are exposed. It will be described here as a supplementary reference section.

Reference section: The Dunphy Formation is subdivided into the following two members at the Romanet Lake section: (1) laminated slate and siltstone, (2) pink dolomite.

Black laminated slate and some dark quartzite of the lower member overlie the Chakoniapau arkose with sharp contact. It grades upwards into grey laminated shale, and grey, green weathering laminated siltstone with 1 foot thick lenses of grey, brown weathering dolomite. Member 2 follows with an abrupt contact. It consists of a pink or salmon coloured, white or very light pink weathering dolomite with undulous stromatolites and contains between 1 inch and 6 feet thick interbeds of purple or green siltstone. Blebs, lenses, and irregular patches of grey, fine-grained quartzite are probably derived from chert nodules. The dolomite has locally been ankeritized, particularly where it is strongly deformed; the ankeritized rock is coloured honey yellow and weathers dark brown.

Lateral variations: The lower, pelitic, member of the Dunphy Formation has been observed at few localities. Grey, finely laminated argillites appear to represent it at the rapids of Romanet River at long. 67°55' W. Fine grained, white, laminated quartzite with minor interbeds of laminated argillite are probable equivalents at the head of

Romanet River (long. 67°49' W.). Greenish grey laminated argillites are exposed here and there south of Dunphy Lake, between the Chakonipau arkose, and the few outcrops of the Dunphy dolomite that exist in the gabbro area, and may also belong to the lower member of the Dunphy Formation. The green argillites with interbeds of dolomite at the southwest shore of Cramolet are probably correlative, but are overlain by the du Portage Formation with which they have been described.

The upper member shows little variation in the Romanet-Mistamisk Lake areas southwest of the line trending from the falls of Romanet river at long. 67°55' W. to Duvic Bay of Romanet Lake. It grades into arenaceous rocks toward the east. Light pink stromatolitic dolomite with floating sand grains is present on the island in Romanet Lake opposite Duvic Bay. An association of white quartzite, dolomitic sandstone, and dolomite in 1-6 feet beds represents the formation at the upper part of Romanet River. The formation is strongly deformed at this locality, with the result that dolomites and dolomitic sandstones have been ankeritized.. At Villandré Lake, the formation is represented by alternating beds of white phlogopite marble and white quartzite.

A few outcrops of pink dolomite with bulbous stromatolites represents the formation at Dunphy Lake, at the northeastern shore of Otelnuk Lake, at some small rocks south of Otelnuk Island, and east of Swampy Bay River. Interbeds of dark red very fine grained sandstone are present. The formation contains pockets of very coarse grained pink quartz sandstone at the narrows at the west of d'Argencourt Bay of Otelnuk Lake. North of Effiat Lake the formation is represented by a white marble with stubby actinolite prisms.

Petrography: The laminated shale, siltstone and argillite of the lower member are indistinguishable from those of the overlying Lace Lake Formation, with which they are described. The typical Dunphy dolomite is pink or salmon coloured by finely distributed hematite dust and has a characteristic translucent luster. Floating silt grains are quite common in the western occurrences of the Dunphy dolomite.

Slight metamorphism, through recrystallization of the hematite pigment, causes the dolomite to be white. Strongly metamorphosed varieties have been observed north of Effiat Lake, where the Dunphy dolomite has been transformed to white actinolite-calcite marble close to gabbro sills. The actinolite forms thick prisms up to 2 cm long, and is pseudomorphous after diopside. Talc-calcite schists developed in a narrow zone below the gabbro sills where these are in contact with the Dunphy dolomite. White phlogopite marble represents the dolomite northeast of Romanet Lake.

Ankeritized varieties of the dolomite occur particularly in strongly deformed zones south of Ronsin Lake, at Romanet River, and northeast of Otelnuk Lake. The ankeritized Dunphy dolomite is honey yellow on the fresh surface and weathers dark brown. Some of the ankeritized rocks are extremely coarse-grained.

Stratigraphic relationships and depositional environment

The contacts of the Dunphy Dolomite are exposed in the zone between Ronsin and Romanet lakes where the formation overlies the Chakonipau Arkose, and is overlain by the Lace Lake Formation. The structural situation at these contacts is controlled by sedimentary top determinations. The Dunphy Dolomite is therefore homotaxial to the du Portage Formation which also is above the Chakonipau, and below the Lace lake Formations. This relation suggests that Dunphy Dolomite and du Portage Formation are equivalent.

The facies relations, and lithological similarities also suggest that both formations are equivalent: The du Portage Formation contains several 50 feet thick members of pink stromatolitic dolomites which are indistinguishable from the Dunphy Dolomite. The Dunphy Dolomite, on the other hand, contains thin interbeds of red or purple very fine-grained sandstone as they occur in the du Portage Formation. It furthermore becomes increasingly sandy to the west, especially at d'Argencourt bay of Otelnuk lake.

There is therefore good evidence suggesting that the Dunphy Dolomite is a marine equivalent of the du Portage Formation.

Depositional environment: The Dunphy Formation was apparently deposited in a shallow marine basin trending northwest. Gradation into sandy facies to the west and east suggests that continental source areas existed west and east of the Labrador trough during the deposition of the formation. Water was shallow enough to permit algal growth. Delicate tabular laminations predominate in the shales of the lower member in the basin centre and indicate quiet conditions, and therefore somewhat deeper water, during their deposition.

MILAMAR FORMATION

The name Milamar Formation is here proposed for the metamorphosed arkoses and quartzites and conglomerates containing minor dolomite beds that represent the upper Seward in the east of the Labrador trough. The Milamar overlies the Archaean gneiss of the Wheeler Complex. It grades upwards through a 10 foot thick transition zone into the Lace Lake Formation. The type section is at Milamar

Lake, at lat. 56°16', long. 67°32'.

The Milamar Formation forms a northwest trending zone following Wheeler River. At the type locality metaarkoses and metamorphosed pebble conglomerates overlie the Archaean with a sharp contact. Farther north along Wheeler river beds of white metaquartzite, of metamorphosed conglomerate and of quartz-albite sericite schist are exposed. White marbles occur at two localitites at Wheeler River lat. 56°21' and 56°28' and are believed to belong into the highest stratigraphic zone of the formation.

South of the type locality the formation is represented by metamorphosed coarse-grained feldspathic quartzites and arkoses with beds of pebble conglomerate. The upper 100 feet are finer grained quartz-sericite schists and contain beds of dolomite and of dolomitic sandstone. Some dolomite beds, particularly at Yroquet Lake, south of lat. 56°07' still exhibit the translucent luster that is typical for the Dunphy type dolomites of the upper Seward. Generally, however, all rocks of the formation have been metamorphosed, and their primary textures and structures have been destroyed.

Petrography

The metaarkoses are composed of ca 50% subrounded cataclastic grains of quartz and feldspar (mainly albite, some microcline), set in a fine-grained mortar of sericite, quartz and albite. Feldspar has been strongly sericitized in strongly deformed varieties and the quartz and feldspar are strongly deformed and show undulous extinction. The rocks commonly are well schistose, the schistosity being folded.

More highly metamorphosed arkoses consist of quartz, feldspars, and muscovite. Quartz is present in amoeboid larger and polygonal smaller grains and is strongly deformed and partly granulated. Porphyroclasts of plagioclase (oligoclase and a little microcline) are set in the matrix of quartz granules. A little sericite forms a well developped schistosity. Epidote, calcite and prochlorite are rare.

Metamorphosed conglomerates contain gneiss or feldspar pebbles generally 2-10 cm, rarely up to 30 cm, across, set in a mylonitic matrix of albite, sericite and quartz. Metamorphosed dolomitic sandstones are composed of calcite, epidote, plagioclase, tremolite and quartz, and dolomites commonly contain some calc-silicate minerals (tremolite, talc) in addition to sugar-grained calcite.

Stratigraphic position and correlation

Contacts between the Milamar Formation and gneisses of the Wheeler Complex are exposed east of Wheeler River, between latitudes 56°14' and 56°15' and again at latitude

56°17'. The gradational contact of the unit with the Lace Lake Formation is exposed at the west shore of Yroquet Lake.

Sedimentary structures have been destroyed in the Milamar Formation, or in the rocks with which it is in contact. Therefore top determinations are not available. In westward plunging folds west of Yroquet Lake the unit plunges below the Lace Lake Formation, whereas the gneisses of the Wheeler Complex occur in anticlinal position in regard to the Milamar. Conglomerates with gneiss pebbles and blocks were observed at several localities in the Milamar Formation close to or at the contact of the formation with the Wheeler Complex (between latitudes 56°11' and 56°15'). Consequently it is believed that the Milamar Formation discordantly overlies the gneisses of the Wheeler complex and that it grades upwards into the Lace Lake Formation. It is therefore an equivalent of the upper part of the Seward subgroup. This interpretation is substantiated by the petrographic similarity of dolomites occurring at the top of the Milamar Formation with those of the Dunphy Formation.

<u>Depositional environment</u>: Not much can be said about the conditions, under which the rocks of the Milamar Formation were laid down. The coarsely clastic character of most of the formation suggests deposition close to a continental source area located farther east. Dolomites at the top of

the formation were probably deposited under water, and suggest that at least minor marine transgressions occurred. It is of course quite possible that the whole of the Milamar has been deposited in a marine-littoral environment.

PISTOLET SUBGROUP

The Pistolet Subgroup (Dimroth 1969) is a sequence of argillites, shales, siltstones, sandstones, quartzites and dolomites. Its type area is at Pistolet lake in the Lace Lake area, where all formations composing this unit occur. The Seward Subgroup is subdivided into three formations:

1. The Lace lake Formation, composed of shales, argillites, siltstones and very fine-grained sandstones with beds of dolomite.
2. The Alder Formation, composed of a grey stromatolitic dolomites, dolomitic sandstones, and white quartzites.
3. The Uvé Formation, characterized by a dark grey, brown weathering massive dolomite.

The Alder and Uvé Formations contain members which are indistinguishable from the Lace lake Formation.

The formations of the Pistolet Subgroup have been subdivided into many members, which permitted a detailed correlation between the different parts of the area. The subdivision and correlation is shown on table 7. It forms the backbone of the regional correlations.

The subdivision of the Pistolet Subgroup into three Formations, in its typical form, can be used in the whole of the Castignon, Otelnuk, Romanet, Dunphy, and Wheeler River areas, except for the zone between Luche Lake and Girafe Lake, in the northwest of the Brèche lake map-sheet. It is also applicable, without modification, to most of the Granite Falls area.

Particular facies of the Pistolet Subgroup are present in the Luche Lake-Girafe Lake zone, in the Cramolet Lake area, and in the southeast of the Granite Falls area. The boundary between the Alder and Uvé Formation has been redefined in the Cramolet and Granite Falls areas; on the other hand a subdivision has not been attempted in the Luche Lake-Girafe Lake zone, in this report, and this zone will be described separately.

LACE LAKE FORMATION

The Lace Lake Formation, adopted from Guy Perrault (1954), is an assemblage of green micaceous siltstone and sandstone, and gray argillite with minor beds of silty dolomite and calcareous sandstone. Red colored sandstone and siltstone occur locally. Base and top of the formation are marked by a profound change in lithology.

Table 7 Stratigraphical sections through the Pistolet Subgroup

	NORTH OF PISTOLET LAKE (western marginal facies)		NORTHEAST OF LACE LAKE (western marginal facies)
	graphitic slate (Hautes Chutes Formation)		Wishart quartzite
	contact not exposed		UNCONFORMITY
300'	grey, buff weathering massive dolomite with black chert nodules		missing
30'	dolomitic sandstone, grey, brown weathering		
200'	red and green laminated argillite, siltstone and very fine-grained sandstone with 3-30 feet beds of grey, brown weathering massive dolomite	200'	grey laminated siltstone and very fine-grained sandstone with a 30 foot bed of grey, brown weathering dolomite
200'	grey, grey weathering stromatolitic dolomite	100'	grey stromatolitic dolomite with some interbeds of brown weathering dolomitic sandstone and calcarenite
	Interlayered stromatolitic dolomite, calcarenite, and dolomitic sandstone	150'	grey brown weathering dolomitic sandstone and calcarenite
			white quartzite
30	grey brown weathering dolomitic sandstone	150'	red and green laminated argillite, siltstone, and very fine-grained sandstone with beds of orange dolomite
			dolomitic sandstone and calcarenite
			white quartzite
	Lace lake Formation not exposed	900'	Lace lake Formation: see table 8
	red sandstones and calcarenites (du Portage Formation)		red sandstones and calcarenites (du Portage Formation)

Table 7 continued

	AT TRIDENT LAKE (submarginal facies)		AT NONA LAKE (western marginal facies)
	graphitic slate (Hautes Chutes Formation)		
	contact not exposed		top not exposed
200'	grey, buff weathering, massive dolomite	200'	grey, buff weathering, massive dolomite
200'	red and green laminated argillite, siltstone, and very fine-grained sandstone with some 5'-20' beds of grey, brown weathering dolomite	200'	red and green laminated argillite siltstone, and very fine-grained sandstone with some 5-20 foot beds of grey, brown weathering dolomite
300'	grey, grey weathering stromatolitic dolomite with beds of grey, grey weathering calcarenite	250'	interlayered sequence of grey, grey weathering stromatolitic dolomite and grey, brown weathering dolomitic sandstone in 1-6 feet thick beds
		50'	grey, brown weathering dolomitic sandstone and calcarenite
<200'	red and green laminated argillite, siltstone, and very fine-grained sandstone with 1-10 foot beds of brown or orange weathering dolomite	<200'	red and green laminated argillite, siltstone, and very fine-grained sandstone with 1-10 foot beds of brown or orange weathering dolomite
	base not exposed		base not exposed

Table 7 continued

NORTH OF VERONOT LAKE (submarginal facies)		SOUTHWEST OF OTELNUK LAKE (submarginal facies)	
	top not exposed		top not exposed
100'	grey, buff weathering massive dolomite	100'	grey, buff weathering, massive dolomite
		100'	black chert grey shale
200'	grey, purple, and green laminated argillite and siltstone, with some beds of green very fine-grained sandstone and with some 1' beds of dolomite	100'	dark grey, brown weathering massive dolomite
		100'	grey laminated argillite and siltstone
200'	grey, light brown weathering stromatolitic dolomite	500'	grey, light brown weathering stromatolitic dolomite
	base not exposed		contact not exposed
		?	grey laminated argillite and siltstone

Table 7 continued

	AT RITCHIE LAKE (submarginal facies)		SOUTHWEST OF LAC AU PAS (sandy basin facies)
	black shale (Hautes Chutes Formation)		shale and greywacke
~300'	grey, buff weathering massive, recrystallized dolomite	~500'	grey, buff weathering, massive dolomite with distorted bedding in 30-100 feet beds, alternating with black shale, and impure sandstone
~200'	grey and black argillite and slate	~200'	black shale, laminated shale, pebbly shale and impure sand-stone
~500'	grey, light grey weathering stromatolitic dolomite, some 10 feet beds of grey, buff weathering, massive dolomite	~500'	medium- to coarse-grained grey, massive sandstone, minor impure sandstone
		~50'	grey, buff weathering, massive dolomite with distorted bedding
		~30'	grey, light grey to brown weathering stromatolitic dolomite or calcarenite
		>500'	medium- to coarse-grained grey massive sandstone, minor impure sandstone
	base not exposed		base not exposed
	not present		not present

Table 7 continued

	SW OF LAC CALONNE (sandy basin facies)		NORTH OF LAC CALONNE (sandy basin facies)
	black and grey slate, greywacke (Swampy Bay equivalents)		black and grey slate, greywacke, greywacke conglomerate (Swampy Bay equivalents)
300'	grey, buff weathering massive dolomite with distorted bedding planes	200'	a) grey, buff weathering, massive dolomite, possibly interbeds of sandstone shale; some interbeds of grit.
200'	dark grey, impure sandstone, grey laminated argillite, black shale, some grit	450'	b) grey, medium-grained sandstone and black impure sandstone, argillite and slate, some grit
		60'	dolomite as under a)
30'	grey, grey weathering stromatolitic dolomite or brown weathering calcarenite	550'	c) grey, white weathering quartzite, some thick brown weathering dolomitic sandstone some shale
?	grey, grey weathering sandstone and grit	30'	grey, grey weathering stromatolitic dolomite with brown weathering interbeds of dolomitic sandstone and calcarenite
		100'	dolomite as under a)
		500'	quartzite as under c)
	base not exposed		base not exposed
	not present		not present

Table 7 continued

AT ALDER HILL (transition sandy - dolomitic basin facies)		SOUTHWEST OF CASTIGNON LAKE (dolomitic basin facies)	
	black, graphitic slate (Hautes Chutes) black, graphitic chert (Formation)		graphitic slate (Hautes Chutes Formation)
200'	grey, chocolate brown weathering, locally coarsely stromatolitic, commonly massive dolomite	200'	grey, brown weathering, chocolate brown weathering massive dolomite, grading laterally into light grey, light brown weathering massive dolomite
200'	red and green argillite and siltstone with some 4"-6' beds of grey, brown weathering beds of dolomite or dolomitic sandstone. One 30' interbed of grey, brown weathering massive dolomite	200'	grey shale and siltstone with beds of grey, brown weathering dolomite
500'	brown weathering coarse-grained dolomitic sandstone grey, grey weathering with beds of brown weathering dolomitic sandstone	300'	Interlayered sequence of 1'-6' beds of grey, grey weathering stromatolitic dolomite, and of grey, brown weathering dolomitic sandstone
1000'	Light grey, white weathering massive quartzite. Some 20-30' interbeds of dark grey, brown weathering dolomitic sandstone. Few 5-20 interbeds of grey laminated argillite	500'	grey, brown weathering dolomitic sandstone, local interbeds of white quartzite
	base not exposed		base not exposed
	not present		not present

Table 7 continued

WEST OF CASTIGNON LAKE (dolomitic basin facies)		NORTHWEST OF CASTIGNON LAKE (dolomitic basin facies transition to sandy basin facies)	
	top not exposed		top not exposed
200'	dark grey, chocolate brown weathering massive dolomite	?	dark grey, chocolate brown weathering massive dolomite
	contact not exposed		contact not exposed
200'	grey laminated shale and siltstone with lenses of brown weathering dolomite	?	grey laminated shale and siltstone with lenses of brown weathering dolomite
500'	interlayered sequence of 1'-6' beds of grey, grey weathering stromatolitic dolomite and of grey, brown weathering dolomitic sandstone	600'	very sandy interlayered sequence of 1'-6' beds of grey, grey weathering stromatolitic dolomite and of grey, brown weathering calcarenite and dolomitic sandstone
500'	grey, brown weathering dolomitic sandstone, some 10-20 feet thick beds of white quartzite, local interbeds of red siltstone and argillite	100'	white quartzite
1000'	grey laminated shale and siltstone with lenses of brown weathering dolomite	1000'	grey laminated shale and siltstone with lenses of brown weathering dolomite
	base not exposed		contact not exposed
	?		red fine-grained sandstone (du Portage Formation)

Table 7 continued

AT MINOWEAN LAKE AND WEST OF DU PORTAGE LAKE 1) (sandy basin facies)		NORTH OF DU CHAMBON LAKE (dolomitic basin facies)	
	? top not exposed		black slate, grey siltstone, some beds of brown weathering dolomite (du Chambon Formation)
300'	grey, buff weathering, massive recrystallized dolomite alternating dolomite as above and white quartzite	150'	dark grey, chocolate brown weathering massive dolomite
		0-30'	brown weathering, grey dolomitic sandstone
	base not exposed	0-30'	white quartzite
?	1" to 1' beds of alternating greenish grey siltstone and laminated slate. Some 1' beds of grey, brown weathering dolomite	0-30'	1"-1' beds of alternating greenish grey siltstone, white, very fine-grained sandstone, grey slate, and grey, brown weathering dolomite
800'	grey brown weathering dolomitic sandstone with lenses of grey, grey weathering dolomite	300'	interlayered sequence of 1' to 6' beds of grey, grey weathering stromatolitic dolomite, and of grey, brown weathering dolomitic sandstone
400'	Alternating 1'-20' beds of dolomitic sandstone and of white quartzite	?	grey, brown weathering dolomitic sandstone with beds and lenses of grey, grey weathering dolomite
500'	white quartzite	?	white quartzite base not exposed
700'	grey laminated shale with lenses of grey,brown weathering dolomite ? green laminated argillite and siltstone		not exposed
	red very fine-grained sandstone (du Portage Formation)		

Table 7 continued

	WEST OF ROMANET LAKE 2) (dolomitic basin facies)		AT APPERT LAKE AND ROMANET RIVER (transition dolomitic basin facies to eastern marginal facies)
	black slate, graphitic greywacke and sandstone conglomerate (du Chambon F.)		dolomite conglomerate and graphitic greywacke (Romanet Formation)
			UNCONFORMITY
200'	dark grey, chocolate brown weathering massive dolomite		absent
0-100'	brown weathering grey dolomitic sandstone		
200'	white quartzite		
0-100'	greenish grey siltstone, white very fine-grained sandstone, grey slate, and grey, brown weathering dolomite alternating in 1"-1' beds		absent
700'	interlayered sequence of 1' to 6' beds of grey, grey weathering stromatolitic dolomite and of grey, brown weathering dolomitic sandstone	700'	brown weathering dolomitic sandstone with lenses and layers of grey, grey weathering dolomite, grading southwestwards into interlayered sequence of stromatolitic dolomite and dolomitic sandstone
	grey, brown weathering dolomitic sandstone with beds and lenses of grey, grey weathering dolomite		
300'	white quartzite	300'	white quartzite
>1000'	alternating 4"-1' beds of siltstone, slate, very fine-grained white sandstone and grey, brown weathering dolomite	>1000'	alternating 4"-1' beds of siltstone, slate and very fine-grained white sandstone with dark grey brown weathering dolomite beds
	laminated slate, siltstone, with little very fine-grained sandstone with or without beds of dark grey brown weathering dolomite		laminated slate and siltstone with little very fine-grained sandstone with or without 1"-1' beds of dark grey, brown weathering dolomite
30'	sandstone conglomerate	30'	sandstone conglomerate
	pink stromatolitic dolomite (Dunphy Formation)		pink dolomite with beds of dolomitic sandstone and of white sandstone (Dunphy Formation)

Table 7 continued

NORTHEAST OF ROMANET LAKE (eastern marginal facies)		EAST OF ROMANET LAKE AND WEST OF WHEELER RIVER 3) (eastern marginal facies)	
	eroded		eroded
?	dark grey, chocolate brown weathering dolomite		eroded
200'	white quartzite		
0	not present		eroded
>500'	brown weathering dolomitic sandstone with lenses and layers of grey, grey weathering dolomite	>500'	brown weathering dolomitic sandstone with lenses and layers of grey, grey weathering dolomite. Locally dolomitic gneiss conglomerate and dolomitic dolomite conglomerate
300'	white quartzite. Locally some sandstone conglomerate	200'	white quartzite
	locally 10-30' grey, brown weathering, massive dolomite; white quartz-sericite schist with dolomite and phyllite beds		white quartz-sericite schist, with beds of phyllites, quartz-phyllite and of brown weathering dolomite
>1000'	grey and black phyllite, quartz phyllite and quartz-sericite schist with or without beds and lenses of grey, brown weathering dolomite	>1000'	grey and black biotite phyllites and quartz phyllites, with and without beds and lenses of dark grey, brown weathering dolomite
	base not exposed		contact not exposed
			arkose and conglomerate (Milamar Formation)

Locality (facies of Alder Formation)	
overlying rocks	
upper member	Uvé Formation
lower member	
Alder Formation	
Lace Lake Formation	
underlying rocks	

Remarks

1) lower part of section from Lace lake Formation to lower member of Uvé Formation exposed at Minowean lake. Upper member of Uvé Formation exposed west of du Portage lake

2) Section from Dunphy Formation to lower part of Lace lake Formation exposed south of lat. 56° '. Section from upper member of Lace lake Formation upwards exposed east and northeast of Duoic bay

3) Lower part of section assumed from relations at Wheeler river. Contacts of lower part of section not exposed. Upper part of section exposed at 56°15' east of Romanet lake.

N.B. All thicknesses are estimated

The type section of the Lace lake Formation is at the southeastern shore of Lace lake (Lace lake area) approximately at lat. 56°04', longitude 68°35'. Another well exposed section through the lower part of the formation is in the Lace lake gully at lat. 56°06', long. 68°35'.

Unquestionable equivalents of the Lace lake Formation underlie the areas between de la Concession and Pistolet lake, northwest and north of Castignon lake, northeast of Minowean lake, between Mistamisk and Romanet lakes and east of Romanet lakes. Probable equivalents of the formation occur west of du Portage lake, at lat. 56°02' southwest of Otelnuk lake, northwest and northeast of Dunphy lake and north of Effiat lake. They will be described in a separate paragraph on pp. 69-70.

The Lace lake Formation is subject to considerable facies variation. Three facies zones may be distinguished:

a) the western marginal facies (Concession lake - Pistolet lake)
b) the central basin facies (Chakonipau lake, Romanet lake, Dunphy lake)
c) an eastern facies zone of metamorphic schists (showing possibly marginal influence).

The type section is in the western marginal facies zone, where the Lace lake Formation is amenable to subdivision.

Western marginal facies zone (Concession lake - Pistolet lake)

The western marginal facies of the Lace lake formation is characterized by alternation of two rock assemblages:

a) green laminated siltstones and grey laminated argillites with beds of brown weathering, grey shaly dolomite.

b) red siltstone and fine-grained sandstone with beds of orange weathering dolomite.

The assemblage b) dominates in the lowest and highest stratigraphic levels of the formation.

The Lace lake Formation has been stratigraphically subdivided into members based on key beds. The rocks of the various members are not characteristic, and their mapping is possible only by tracing the key beds. The key beds were chosen in such a way that they conform to major topographic features. The type section is quoted in table 8.

Outcrop of the sequence is not continuous. The members may be traced with reasonable certainty from Lace lake to de la Concession lake. A lower member, composed of 20 feet of red and green laminated siltstone is exposed at the northeastern shore of Concession lake.

Table 8: Type section of the Lace lake Formation

(feet)	
100	Member 5
	alternating beds of red sandstone, siltstone, and quartzite; interbedded minor orange coloured weathering intraclastic dolomite, dololutite, and dolomitic sandstone, and pink chert
200	Member 4
	grey laminated argillite with a few 2 to 3 inch beds of grey, brown weathering, clayey or silty calcilutite and some 2 to 6 foot beds of green siltstone
285	Member 3
50	(5) green, locally green and pink laminated siltstone, grading downwards into (4)
60	(4) same siltstone with 2 inch to 6 foot beds of grey, brown weathering crossbedded intraclastic dolomite and calcilutite, and calcareous sandstone
150	(3) grey, laminated argillite with a few 2 to 6 foot beds of green siltstone and very fine-grained sandstone
10	(2) red siltstone, with slight unconformity overlying (1)
15	(1) red, medium-grained sandstone
	Member 2
6	(4) green laminated siltstone
30	(3) grey argillite, some 2 to 4 inch beds of grey, brown weathering laminated calcilutite and 1 foot

to 2 inch beds of green, laminated siltstone

5 (2) laminated grey, brown weathering calcilutite

150 (1) same as (4) but with more siltstone

- base not exposed -

N.B. All thicknesses are estimated

It is not possible to correlate the sequence exposed in the Lace lake gully (table 9) with the type section described above. The Lace lake Formation is not exposed south and southeast of Pistolet lake, where only float of green laminated siltstones and of grey, laminated argillites signal its presence.

The upper member of the Lace lake Formation is exposed below the Alder Formation in the area north of Roussenet lake and south and southeast of Trident lake. The exposed sequence consists of red and green laminated siltstone, of red and purple fine-grained sandstone, and contains 4"-2' thick beds of orange coloured dolomite, of grey, brown weathering calcilutite, or of grey, brown weathering dolomitic sandstone.

Petrography

Most of the siltstones are grayish green and weather light green. Some siltstones weather orange or pink, and some are orange, pink or red on the fresh and weathered surface. Green, orange, pink, and red siltstones are interlaminated at a number of localities. They are commonly laminated, with bedding planes 5 mm or 1 cm apart, and show a good bedding parallel parting. The bedding planes are somewhat micaceous. The siltstones consist of 60-70% quartz splinters, and some plagioclase, set in a recrystallized matrix of sericite, and chlorite, containing chlorite "eyes" and brown, bent biotite (?) tables. Chlorite and biotite (?) are probably authigenic. The basis of the micaceous minerals are oriented parallel to the bedding.

The shales are gray, or dark gray and finely laminated, dark gray shale laminae alternating with green siltstone laminae. They contain chlorite "eyes", tabular authigenic biotite, and commonly some calcite in a groundmass of clay minerals. Some graphite is present. The siltstone laminae are quite well recrystallized, and consist of quartz splinters (up to 80%) in a matrix of chlorite, clay minerals and calcite. Small calcite concretions are common in these shales. A bedding parallel orientation of the minerals is commonly clearly visible. Graded bedding was observed.

Table 9 Sequence of the Lace lake and du Portage Formations exposed in the Lace lake gully

(feet)		Lace lake Formation
2	(17)	dark red oolitic limestone
40	(16)	green and red medium-grained crossbedded sandstone
100	(15)	grey and green laminated siltstone
10	(14)	dark grey argillite
90	(13)	grey laminated argillite with beds of orange weathering dolomite
5	(12)	buff, light brown weathering brecciated dolomite
10	(11)	green, yellow-orange weathering laminated siltstone
10	(10)	grey siltstone
10	(9)	grey, orange or brown weathering brecciated dolomite
20	(8)	grey siltstone
45	(7)	light yellowish green, yellow-orange weathering laminated siltstone with beds of grey, orange brown weathering dolomite
30	(6)	grey argillite with some beds of orange brown weathering dolomite
15	(5)	green and pink thickly bedded siltstone
		du Portage Formation
10	(4)	purplish, brown weathering medium-grained, dolomitic sandstone
40	(3)	purplish red fine-grained sandstone
10	(2)	dark green siltstone
	(1)	buff, fine-grained, crossbedded sandstone

The limestones are light gray, less commonly orange and weather brown or orange. They commonly show bedding on a scale of 1 cm and fine laminae (0.3-0.5 mm thick). Cross-laminations are common. The limestones consist of very fine-grained calcite; they contain some silt and clay minerals. Intraclastic limestones are common.

The pisolitic limestone is gray, brown weathering. It consists of relatively well recrystallized calcite. Deformed pisolitic textures of 1 x $\frac{1}{4}$" size are poorly preserved.

The red sandstone is medium-grained (up to 1 mm), and commonly well sorted. The clastic grains compose 50-80% of the rock; they are well rounded. Most of the fragments (up to 80%) are quartz. Limestone and chert fragments and chlorite granules, commonly with a quartz core are common. Some sandstone contain chloritic oolites or calcareous oolites. The clastic fragments are commonly coated by cryptocrystalline hematite. Uncoated fragments have been etched in most cases where they are cemented by calcite. The fragments are cemented by calcite, or by chalcedonic chert, or they are embedded in a ground-mass of clay rich in hematite. Sandstones cemented by chert show normal packing index; those with a clay matrix are strongly compacted. Sandstones cemented by calcite show extremely irregular packing.

Basin facies

The basin facies of the Lace lake Formation is characterized by grey argillites and shales. It contains some beds of very fine-grained sandstone, and beds and lenses of grey, brown weathering dolomites. A 10-20 feet thick bed of sandstone conglomerate is present in the eastern portion of the region.

The basin facies of the Lace lake Formation is exposed north of Castignon lake, northeast of Minowean lake, between Mistamisk and Romanet lakes and southeast of Romanet lake.

It was not possible to subdivide the Lace lake Formation in the area north of Castignon lake, and northeast of Minowean lake, where it is represented by a sequence of grey laminated shales and siltstones with 4"-10' thick beds and lenses of grey, brown weathering dolomite.

A 10-20 feet thick bed of sandstone conglomerate is at the base of the Lace lake Formation in the Romanet lake area. This bed is a characteristic marker horizon at Romanet lake. The sandstone conglomerate is overlain by grey laminated shales and siltstones with some 1-2 inches thick beds of very fine-grained sandstone. The shales and siltstones with thin beds of very fine-grained sandstone make up the main body of the formation. They commonly contain lenses and beds, between 1 inch and 2 feet thick, of grey, brown weathering dolomite. A ca 100 feet thick sequence of between 1 foot and 3 feet thick beds of white very fine-grained quartzite or quartz-sericite schist, of greenish grey siltstone, and of brown weathering dolomite is at the top of the formation.

All these rocks have been metamorphosed in the eastern portion of the area. They have been converted to phyllites east of Romanet river, and to biotite phyllites east of long. 67°43'. The rocks of the formation exposed at Wheeler river are mica-schists.

Petrography

The laminated siltstones and shales exposed in the area north of Castignon and northeast of Minowean lake are composed of sericite, chlorite, of silt size (0.05-0.1 mm) splinters of quartz and of some albite splinters. The silt fraction varies from 0 to 80%. Some graphite is commonly present in the shale laminae free of silt. In shales sericite and chlorite are commonly oriented parallel to the bedding. 0-30% carbonate (calcite?) is present in many sectionsand forms porphyroblasts. The laminae are between 0.5 and 20 mm thick. Graded laminations are common. A slaty cleavage, parallel to the axial plane of microfolds was observed in a number of sections in the area northwest of Castignon lake. A slaty cleavage and one, or several fracture cleavages, are present in the Romanet-Mistamisk lake valley.

The dolomites are dark grey, and weather brown. They are strongly recrystallized, and are now composed of a finely crystalline (0.05-0.2 mm) aggregate of carbonate. The grain size varies strongly even within the domain of a thin section.

The slates grade into phyllites, east of longitude 67°50'. It appears that grey slates are more easily converted to phyllites than graphitic slates. The phyllites commonly show a fine lenticular lamination parallel to the schistosity. This lamination is easily mistaken for bedding, whereas it is in reality due to metamorphic differentiation. Here and there bedding is marked by more silty layers or by dolomitic beds; where this is the case the schistosity can be shown to be parallel to the axial planes of folds of the bedding.

Eastern facies (east of Romanet Lake)

The basin facies of the Lace Lake Formation grades continuously into an eastern facies of metamorphic quartz-phyllites that contains a relatively large proportion of metamorphosed fine-grained sandstone and dolomitic sandstone. Clearly recognized equivalents of the Lace Lake Formation extend toward Wheeler River in the east. They are overlain by shales, and basalts of the Bacchus Formation, and by gabbro sheets.

Lithologically similar beds compose the lowermost part of the Laporte Schist east of Duhamel Lake. They grade upwards into a sequence of pelitic and semipelitic schists with interlayered gabbro sheets. The Murdoch Formation follows. It is possible, but not certain, that the basal parts of the Laporte schist are equivalents of the Lace Lake.

Petrography

The shales have been converted to biotite-sericite-chlorite-quartz-albite schists. They contain numerous thin interbeds of biotite-sericite quartzites. Calcareous sandstones have been converted to more or less schistose rocks composed of calcite, epidote, biotite, chlorite, tremolite, quartz and albite.

The pelitic rocks contain a well developed schistosity, and generally one or two, less commonly three strain slip cleavages. Quartzitic rocks have generally one or two poorly developed cleavages that correspond to the best developed sets of cleavages in the pelitic rocks. The calcareous rocks are relatively massive. Bedding is commonly well preserved even in highly deformed rocks and is recognized by compositional variations on a cm-scale.

Correlation and depositional environment

All the occurrences of the Lace lake Formation described above are in contact with the Alder Formation above, or with the du Portage or Dunphy Formations below, or with both.

Top determinations confirm the position of the Lace lake in all areas described, they have been made either in the Lace lake Formation, or in the underlying or overlying rocks. The stratigraphical position of the described occurrences is therefore certain.

Depositional environment

Red and green colours in the western marginal facies suggest deposition in an oxidizing environment. Cross-lamination, and flaser laminations are characteristic of siltstones and fine sandstones; calcareous rocks are coarse conglomeratic intramicrites, or crossbedded calcisiltites. These textures are characteristic of deposition in a turbulent aqueous medium. Minor unconformities suggest that brief periods of subaerial exposure occurred. The western marginal facies contains a relatively high proportion of fine sandstone and siltstone denoting deposition closer to a source of clastic material than the basin facies, although the source must still be relatively distant. These characters suggest deposition in a littoral or sub-littoral environment.

The pelites of the basin facies contain graphite, which indicates deposition in a reducing environment. Pelitic rocks predominate. They are characterized by tabular laminations. Calcareous rocks are massive micrites. The basin facies was therefore deposited in relatively deep basin under quiet conditions. Increasing sand component in the east of the trough proves the presence of a second source area extending somewhere east of Wheeler River.

The Lace Lake Formation is therefore thought to be deposited in a marine basin that extended in a NNW-SSE direction. The shores of the basin were not too far west and east of the present margins of the Labrador trough.

Rocks of uncertain stratigraphic position correlated with the Lace lake Formation

Shales and argillites occurring at the following localities were correlated with the Lace lake Formation:

1. west of du Portage Lake
2. northeast of du Portage Lake
3. northwest and northeast of Dunphy Lake
4. north of Effiat Lake
5. at lat. 56°06' N, long. 68°15' W, southeast of Otelnuk Lake

Zone 1: Laminated grey shales and argillites are exposed at lat. 56°25', long. 68°28' west of du Portage lake. The rocks do not contain beds or lenses of dolomite. The shaly rocks are similar to those of the Lace lake Formation exposed northeast of Castignon lake below the Alder Formation, which are also devoid of dolomite beds. They are in contact with rocks of the du Castor Formation. They were correlated with the Lace lake Formation because an outcrop of unquestionable

Lace lake, is exposed farther south, at lat. 56°22', long. 68°28' in contact with rocks of the du Portage Formation. This outcrop is separated by ½ mile of unexposed terrain from the occurrences described above.

The occurrences 2, 3 and 4 are in a continuous structural zone below the gabbro sheets of the Coussinet Lake zone, or between the lowermost gabbro sheets. A zone of Dunphy dolomite is sparingly exposed below the questionable occurrences between Otelnuk and Effiat Lakes; the Dunphy dolomite is structurally below the outcrops of questionable Lace Lake. Its presence substantiates the correlations, which appear to be fairly certain. Northeast of du Portage Lake on the other hand, the Dunphy Dolomite is absent, and the strata described here could be equivalents of the du Portage Formation.

Zone 2: A sequence of alternating grey and greenish grey argillite, green, fine grained sandstone, with interbeds of purple and red argillite and sandstone has been followed in a northwest trending valley at the foot of the scarp that bounds the gabbro-basalt area of Coussinet Lake. Laminated grey argillites overlie the variegated sequence. The sequence could in part be equivalent to the du Portage Formation.

Zone 3: Laminated argillites with between 1" and 1 foot thick beds of grey, brown weathering shaly dolomites are exposed west and east of the Septentrionale bay of Dunphy Lake.

These rocks are characteristic of the Lace lake Formation and are structurally above the Dunphy Dolomite. It is fairly certain that their correlation with the Lace lake is correct.

Zone 4: Grey laminated slates, and layered talc-muscovite schists are sparingly exposed north of Effiat lake. These rocks are structurally above a tremolite marble correlated with the Dunphy Formation. Similar rocks occur at the base of the gabbro sheets, and between the lowermost gabbro sheets northeast of Otelnuk Lake, where they are also above the Dunphy Formation.

Area 5: An outcrop of laminated argillite is exposed southeast of Otelnuk Lake (lat. 56°06' N, long. 68°15' W). The outcrop is structurally below stromatolitic dolomites of the Alder Formation.

ALDER FORMATION

The Alder Formation (Dimroth 1969) is an assemblage of stromatolitic dolomites, calcarenites, dolomitic sandstones and white quartzites. The type locality is at Alder Hill, east of the South bay of Chakonipau lake, where a continuous and typical section through the formation is exposed.

The Alder Formation is subject to extreme facies variation. The following facies districts have been distinguished:

1. western marginal facies
2. northwestern marginal facies (described as probable equivalents of the Alder Formation (on pp. 84-86)
3. dolomitic basin facies
4. sandy basin facies
5. eastern marginal facies

The type locality is transitional between the sandy and dolomitic basin facies. It will be described first. Descriptions of the lateral facies variations will follow, and the description of the petrography will be deferred to a final section. Somewhat simplified sections across the formation at various places are given in table 7.

Type section

The Alder Formation has been defined at Alder Hill, east of the southern bay of Chakonipau Lake (lat. $56^{o}11'$, long. $68^{o}26'$). It is subdivided in two members at the type locality. The lower member is sandy, and consists of white quartzite with some 50' beds of dolomitic sandstone and with some 10 or 20 feet thick lenses of grey, laminated argillites. The upper member consists of a sequence of interbedded grey weathering stromatolitic dolomite and dolomitic sandstone (interlayered sequence). For details see table 10.

Western Marginal Facies (Concession Lake - Pistolet Lake)

In the zone between De la Concession lake and Pistolet lake the Alder Formation is developed in a sandy, marginal facies. A lower member, composed mainly of dolomitic sandstone, is very thick; an upper member is composed of an interlayered sequence of alternating beds, each between 1 and 6 feet thick, of grey, grey weathering stromatolitic dolomite, and of brown weathering dolomitic sandstone and calcarenite. The interlayered sequence grades upwards into stromatolitic dolomite. Interbeds of red argillite, siltstone, very fine-grained sandstone and quartzite with orange coloured dolomite beds occur close to the base of the formation. Good sections are exposed north of Pistolet lake and east of Lace lake, and are listed on table 7.

Sub-marginal facies zone (West of Otelnuk Lake - Veronet Lake - Trident Lake)

The Alder Formation is composed of alternating calcarenite and stromatolitic dolomite at Trident lake. Sandy beds and shale members are absent.

At Nona Lake the formation is subdivided in two members. The lower member consists of dolomitic sandstone and calcarenite, the upper member of an interlayered sequence of dolomitic sandstone and stromatolitic dolomite. The facies is transitional into the marginal facies.

Table 10: Type section of the Alder and Uvé Formations

200' 20'	black, graphitic slate black, graphitic chert	Hautes Chutes Formation	
200'	grey, brown weathering, commonly massive dolomite, locally distorted laminations	Upper member	UVE
50'	red and green argillite and siltstone, with some 4" - 6' beds of grey, brown weathering dolomitic sandstone	Lower	
30'	grey, brown weathering dolomite, massive, slightly sandy at base	member	FORMATION
100'	red and green argillite and siltstone with some 4" - 6' beds of grey, brown weathering dolomite or dolomitic sandstone		
20'	brown weathering coarse grained dolomitic sandstone	Upper member	
200' 500'	grey, light grey weathering stromatolitic dolomite alternating with beds of brown weathering dolomitic sandstone		ALDER
1000'	mostly grey, while weathering, massive quartzite; some 20-30' beds of dark grey, brown weathering, cross-bedded dolomitic sandstones; few 5-20' beds of grey argillite	Lower member	FORMATION

fault contact

Stromatolitic dolomite composes the formation between Veronot Lake and Maraude Lake. Minor interbeds of dolomitic sandstone and of calcarenite occur again south of Maraude Lake. 10 feet thick interbeds of a grey, buff weathering dolomite indistinguishable from the dolomite characteristic of the Uvé Formation occur close to Ritchie Lake.

Dolomitic basin facies (western zone, west and south of Castignon Lake)

The Alder Formation is subdivided in a lower member composed of dolomitic sandstone and of white quartzite and an upper member composed of alternating beds of stromatolitic dolomite and dolomitic sandstone in the zone west of Castignon Lake. The lower member is ca 1000 feet thick in the type area south of Chakonipau lake. Its thickness decreases rapidly to the west, and the lower member is a 500 feet thick west of Castignon lake, and not more than 100 feet thick northwest of Castignon lake. The upper member maintains more or less constant thickness and facies over the area south of Chakonipau and west of Castignon lake. It grades rapidly into calcarenites northwest of Castignon lake.

Lenses of grey argillite, or of red argillite and siltstone with beds of brown weathering dolomite were observed in the lower member at a few localities.

Sandy basin facies (Minowean Lake, Wakuach Lake)

At Minowean Lake the Alder is composed of an extremely thick sequence of white quartzite overlain by dolomitic sandstone. A interlayered zone occurs in the middle of the formation. A few 20 feet thick beds of grey argillite are present close to the base of the formation at number of localities.

Southeast of Chakonipau Lake the formation consists of 1000 feet of white quartzite, overlain by up to 500 feet of alternating stromatolitic dolomite and dolomitic sandstone. Dolomitic sandstone predominates. The type section does not represent the typical sandy basin facies.

Northwest of Wakuach Lake the formation is represented by very thick quartzite, dolomitic sandstone, grit, and microconglomerate. A few 10-30 feet beds of brown weathering massive dolomite occur; they are similar to the dolomite that is otherwise characteristic of the Uvé Formation. The massive dolomite beds grade laterally into dolomitic sandstone. A few 10-30 feet beds of stromatolitic dolomite and of grey weathering calcarenite occur as characteristic members.

Dolomitic basin facies and Eastern marginal facies (Romanet Lake)

The Alder Formation is subdivided in two members in the Mistamisk-Romanet lake valley. The lower member is composed of white quartzite, the upper member of dolomitic sandstone or of an interlayered sequence of dolomitic sandstone and grey stromatolitic dolomite. The lower member does not change much within the zone. It is commonly massive, locally well bedded. It comprises sandstone conglomerates at some localities northeast of Romanet lake.

The upper member is composed of dolomitic sandstone with some dolomite beds at the base grading upwards into the interlayered sequence with predominating dolomite in the area north of du Chambon and Bertin lakes. Towards northeast, the formation grades into dolomitic sandstones comprising lenses and beds of grey dolomite. Dolomitic sandstones containing between 10 and 30% of beds of stromatolitic dolomite predominate west of Appert lake, and south of Romanet river. Dolomitic sandstones containing 10% or less of lenses and beds of dolomite predominate northeast and east of Romanet lake. These sandstones contain grits and conglomerates at certain localities: grits with siltstone fragments of up to 5 mm diametre were observed in the area west of Appert lake. Sandstone conglomerates, occur at two localities northeast of Romanet lake. Gneiss conglomerates, composed of gneiss and granite fragments of up to 10 cm diametre in a slightly dolomitic arkose matrix were seen at two places east of Romanet lake. Glacial blocks of dolomite conglomerates, composed of dolomite pebbles of up to 5 cm diametre and of quartz pebbles in matrix of dolomitic sandstone were observed east of Romanet lake. They may be derived from the Alder Formation, but may also come from equivalents of the Romanet Formation.

Argillitic units of the Alder Formation

10-50 feet thick discontinuous beds of argillitic rocks were mapped in the lower member of the Alder Formation in the area east of Lace lake, west of Castignon lake, northeast of Castignon lake, southeast of Chakonipau lake and northwest of Wakuach Lake. The argillitic rocks are very similar to the rocks of the Lace lake Formation.

Red or red and green argillite, siltstone, very fine-grained sandstone, with beds of orange or brown weathering dolomite occur east of Lace lake and west of Castignon lake. These rocks are anologuous to the marginal facies of the Lace lake Formation. Grey argillite, analoguous to the basin facies of the Lace lake Formation occur northeast of Castignon lake, southeast of Chakonipau lake and at Wakuach lake. Grey siltstone, and very fine-grained sandstone with beds of grey, brown weathering dolomitic sandstone occur at Roussenet lake. These rocks are as quartzose as are normally those of the marginal facies of the Lace lake, and grey, as is its basin facies. It is believed that they were deposited in an embayment of the western shore of the geosyncline.

Petrography

The stromatolitic dolomites are commonly light gray, rarely yellowish or dark gray on the fresh surface and weather white, or light cream. They are fine-grained and have a conchoidal fracture. Stromatolites are commonly present in many growth forms ranging from wavy laminations to cauliflower shaped structures. Stromatolites ca 2-3 inches across are characteristic of most parts of the formation. They are good top indicators. At many localities they are obscured by 1 or 2 mm wide quartz veins which commonly fill fractures and small faults with displacement of up to 1 inch. Small open spaces which were left open between stromatolitic laminae and between the individual stromatolites are filled with coarse-grained white calcite.

The lamellar texture of the stromatolites is well displayed under the microscope and consists of alternating irregular laminae and lenses of fine-grained and coarse-grained calcite, and thin chert laminae. The pervasive recrystallization of the limestone and fractures filled with quartz and chert partly destroyed these structures. A few silt grains are occasionally present. Stromatolitic dolomites at the type locality contain bedding parallel zones filled with coarse dolomite that has a spherulitic texture.

The calcarenites are grey on the fresh surface and weather dark brown or less commonly yellow or cream. They commonly are thickly bedded; crossbedding is common. Calcareous pisolites and oolites, oolites, pisolites, commonly contain quartz or limestone fragments in the centers. Calcareous intraclasts, fragments of calcilutite and of calcareous siltstone occur as clastic fragments and are mixed in variable proportion with quartz sand. Many oolites are composite. The clastic fragments are cemented by a dolomitic matrix.

The calcareous sandstones are gray or white and weather dark brown. They are thickly bedded and crossbedded. They consist of fragments of quartz (40-60 %), of limestone oolites (0-15%), of limestone intraclasts (0-15%), and of calcareous siltstone fragments (0-5%) and locally contain shale fragments. The matrix is a coarse-grained dolomite (spar). They grade into sandstones containing ca 60% quartz fragments, a little feldspar (microcline and plagioclase), rare chert fragments and some shale fragments in a matrix of coarse calcite and a little chert.

The white quartzites are commonly massive, and structureless. Bedded varieties were locally observed and are not characteristic. They are middle grey on the fresh surface and weather light grey or white. They are commonly orthoquartzites. The sand grains - mostly quartz, a little feldspar are outlined by dust rings. Cementation is either by cherty quartz or, by outgrowths of the original grains. A little dolomite is commonly present. The white quartzites are commonly somewhat deformed and the quartz grains show undulous extinction. The original clastic texture has been destroyed in shear zones and fault zones and in the strongly deformed rocks of the Romanet-Mistamisk lake valley. The deformed quartzites have metamorphic textures.

Grits and microconglomerates are a common constituent in the Alder Formation northwest of Wakuach Lake, at Lac Colonne, and at lac du Pas. They contain well rounded quartz grains of up to 1 cm diametre, quartz sand, and some shale chips. The clastic components are cemented by chert or by clay.

Sandstone conglomerates occur in the Alder Formation east of Romanet lake, and are similar to those of the du Chambon Formation described on p. 94.

Granite conglomerates exposed at a two places east of Romanet lake are composed of granite fragments of

2-10 cm diametre, set in an arkosic matrix cemented by dolomite.

The argillites, siltstones and very fine-grained sandstones locally interbedded with the sandstones of the lower member of the Alder Formation are analoguous to the rocks of the Lace lake Formation described on pp. 62-67.

Stratigraphy and correlation

The sections through the Pistolet Subgroup described on table 4 prove that there can be no doubt about the correlation between the different occurrences of the Alder Formation. Top criteria have been found in all areas where the formation occurs, excepting only the area east of Romanet lake.

Depositional environment

The stromatolites that are characteristic of the Alder Formation, are structures produced by blue-green algae. They correspondingly grow only in a marine environment, at a depth not exceeding a few metres. Pelitic interbeds are similar to the marginal, red and green facies of the Lace Lake in the area west of Castignon Lake, whereas those farther east are analog to the basin facies.

The predominance of sandstones in the western marginal facies suggests that a continental foreland extended not far west of the present boundary of the trough, and shed clastics to the east. A narrow submarginal "reef" zone, composed predominantly of dolomitic material extends toward the basin. Sand deposited east of this zone is likely derived from the east or north. Conglomeratic and very arenaceous facies east of Romanet Lake suggest that a second continental source area extended east of the trough.

Of particular interest are grits and micro-conglomerates in the Alder Formation northwest of Wakuach Lake, at Lac Colonne, and at lac du Pas. These conglomerates can be derived only from the east because a submarginal facies zone, relatively devoid of continent derived material, extends farther west at Ritchie Lake. Their relatively coarse grain - exceeding 1 cm in some horizons - indicates that the source is relatively close. They are associated with dolomites of Uvé type that show synsedimentary deformation structures, and with conglomerates containing pebbles of shale and siltstone. These features appear to indicate that the Alder Formation was deposited at a slope dipping west in the area northwest of Wakuach Lake. It is furthermore inferred that a source area extended little farther east, in the centre of the trough. The source area appears to mark the first appearance of a geanticlinal zone in the centre of the trough. No trace of the central geanticline exists north of 56° latitude.

UVE FORMATION

The Uvé Formation (Dimroth 1969) is characterized by a 100-300 feet thick horizon of dark grey, brown or buff weathering massive dolomite. The area south and west of the Etang d'Uvé has been defined as type locality (lat. 56°11', long. 68°26').

The separation between the Alder and Uvé Formations is straightforward in the area north of 56°00' N, and in the Granite Falls area, except for the zone between Luche and Girafe Lakes. It is impossible to propose an equivalent subdivision of the Pistolet Subgroup in the Luche-Girafe Lake zone, and the rocks have been mapped as unsubdivided Pistolet. Between Wakuach and Le Pas Lakes dolomites of Uvé type occur alternating with sandstones and grits, that also have interbeds of calcarenite typical of the Alder Formation. This unit has been correlated with the Alder Formation. It is overlain by a unit composed of several beds of Uvé type dolomite alternating with mainly pelitic rocks; some interbeds of sandstone and microconglomerate occur in the pelitic zones. This upper unit has been correlated with the Uvé Formation.

Type section and lateral variation

The type section of the Uvé Formation is shown on table 10. It is subdivided into a lower member composed of argillites, siltstones and very fine-grained sandstones, with dolomite beds and lenses, and an upper member composed of dolomite, and including dolomitic sandstone and white quartzite at certain localities.

Facies variation of the Uvé Formation is not very strong. A marginal facies, present between Pistolet and De la Concession Lakes, is characterized by red and green silty and fine-sandy sediments in the lower member. Elsewhere the rocks of the lower member are grey slates. Grey quartzites and dolomitic sandstone occur at the base of the upper member east of Minowean Lake and in the Mistamisk-Romanet Lake valley; their thickness increases to the east.

The subdivision in a lower and upper Member is not recognized south of 56°00'. Between Maraude Lake and Au Pas Lake the formation is composed of about 10 beds of massive brown weathering dolomite 10-60 feet thick, alternating with 30-200 feet of black slate. Between Lac Calonne and Wakuach Lake the Uvé is composed of one or several 30-200 feet thick beds of dolomite, alternating with one or several 30-100 feet zones of shale, grit and microconglomerate (see table 7).

Petrography

The Uvé dolomite occurs in two varieties: An aphanitic variety, and a recrystallized variety. The aphanitic dolomite is dark grey and weathers chocolate brown, commonly with a peculiar violet brown tinge. In many localities the formation is bedded, elsewhere it may be homogeneous and structureless. Synsedimentary deformation structures and synsedimentary brecciation are common. Bedding is visible only on the weathered surface where shows by slight colour variation. Dolomite with deformed bedding grades into brecciated dolomite and into dolomite with patchy lenticular bedding. However the aspect of the formation is dominated by the massive appearance of the dolomite member. Patches of coarse dolomitic sandstone are not uncommon at the base of the dolomite beds.

The recrystallized dolomite is light grey, or yellow, rarely dark grey, and weathers light brown. It is commonly sugar-grained, although quite coarse varieties (grain size 3 mm and more) were locally observed. Sedimentary structure were never observed in the recrystallized variety and probably have been destroyed. Black chert, on the other land is always present. The chert may form concretions, or may fill cracks and veins in the rocks. The recrystallized dolomite commonly shows some tectonic brecciation.

Dolomitic microconglomerates containing ca 15-20% of quartz sand and chert fragments of 1 cm maximum length in a groundmass of yellow dolomite were observed at a number of localities. The chert fragments show an irregular bedding lamination, and consist of graphitic slates now largely replaced by chert. They are fractured and the fractures are filled with fine recrystallized chert. The dolomite replaced part of the chert, enclosing its graphite dust.

The aphanitic dolomite predominates in the occurrences of the Uvé Formation northwest, west and south of Castignon lake and in the Romanet lake area. The recrystallized dolomite predominates west of du Portage lake, between Pistolet and Roussenet lakes, and west of Otelnuk lake, and south of lat. 56° N. Changes from one facies into the other are abrupt.

The dolomitic sandstones and white quartzites occurring in the Uvé Formation are similar to those of the Alder Formation, and the argillaceous rocks of its lower member correspond exactly to the rocks of the Lace Lake Formation. Therefore their descriptions are not repeated here. Grits and microconglomerates occur at Lac Calonne and Wakuach Lake and also are analog to types present in the Alder Formation. Dolomite conglomerates, containing pebbles of up to 10 cm length of dolomite were observed close to lac Calonne. The pebbles appear to be deformed and have probably been incorporated in the sediment before they were consolidated.

<u>Correlations:</u> The stratigraphical sections shown on table 7 permit detailed correlations between all

occurrences of the Uvé Formation. Sedimentary top determinations were possible at all areas where the Uvé Formation occurs and the stratigraphical equivalence of all occurrences is therefore certain.

Depositional environment: Stromatolites are absent from the Uvé dolomite, and black graphitic slates with delicate tabular laminations predominate in the basin facies. Both features suggest deposition in relatively still and deep water for the main body of the formation. Pelitic rocks in marginal facies, analog to the Lace Lake, exist only in a narrow zone in the west of the trough. Arenaceous beds occur in the centre and east of the trough; they thicken to the east and are therefore interpreted as indicating the presence of a continental area east of the trough. Another source area may have existed in the centre of the trough, east of Wakuach Lake.

PROBABLE EQUIVALENTS OF THE PISTOLET SUBGROUP

A sequence of predominantly argillitic rocks unconformably overlies the Pre-Kaniapiskau basement in the Luche-Girafe lakes zone. The argillitic rocks of this sequence are very similar to the argillites interlayered with the sandstones and dolomites of the Alder and of the Uvé Formations, and the sequence includes beds of white quartzite and of dolomitic sandstone typical of the Alder, and of brown weathering dolomites, typical of the Uvé Formation. The sequence is not too well exposed, and is therefore imperfectly known. A section, combined from many outcrops is as follows:

Table 11 Pistolet Subgroup (Luche lake - Girafe lake zone)

(feet)		
500	(6)	grey argillite and siltstone locally with 1 foot thick lenses and beds of a brown weathering dolomite.
0-200	(5)	brown weathering, dark grey Uvé dolomite, locally breccious or stromatolitic.
100	(4)	grey argillite and siltstone with lenses and beds of brown weathering dolomite; gradational contact to (3).
500	(3)	red and green siltstones and argillites, with 10-50 feet interbeds of medium-grained bedded purple sandstone, of white quartzite, and of dolomitic sandstone.
100	(2)	white quartzite; gradational contact to 1.
200	(1)	medium-grained pink arkosic conglomerate.
		UNCONFORMITY
		granite

The white quartzites of members (2) and (3) are indistinguishable from those of the Alder Formation. The dolomitic sandstones are in part calcarenitic (e.g. south of Girafe Lake), and contain up to 1 foot thick lenses of light grey weathering dolomite with wavy stromatolitic laminae, as they occur in the calcarenitic beds of the Alder Formation. The brown weathering dolomite of member (5) occurs only at certain localities, and is characteristic of the Uvé Formation. It is therefore assumed that the whole sequence correlates with the Alder and the Uvé Formations. The boundary between members (3) and (4), or the top of the uppermost bed of white quartzite or dolomitic sandstones should approximate the boundary between both formations. It may not be exactly equivalent to the boundary defined at the type locality, but should not be more than 100 feet from it. The brown weathering dolomite is therefore assumed to be nearly at the base of the assumed equivalent of the du Castor. The evidence indicates that it corresponds to one of the dolomite horizons of the lower member of the du Castor, and that the main dolomite horizon of this formation is absent in the Luche lake - Girafe lake zone. The uppermost unit (6) appears to grade laterally and vertically into rocks similar to the Savigny Formation, and may be its equivalent in part.

Petrography: The arkosic conglomerate of this unit is a very coarse-grained (<1 cm), pink rock, composed of quartz, plagioclase and microcline fragments bound by a little sericite. It is strongly compacted, intensely folded, and commonly shows a tectonic cleavage. The purple sandstone is composed of grains of quartz sand, and some feldspar, coated by hematite. The sandstone is strongly compacted, and has little pore space. It grades laterally into the white quartzite typical of the Alder Formation, which is commonly somewhat tectonized. Intermediate varieties are light purple or pink on the fresh surface. The white quartzite grades locally into dolomitic sandstones and calcarenites, which correspond to those described with the Alder Formation.

The argillites and siltstones of this unit are indistinguishable from those described with the Lace lake Formation.

ATTIKAMAGEN AND SWAMPY BAY SUBGROUPS

Harrison (1952) introduced the term Attikamagen Formation for a pelitic unit underlying the Wishart Formation at Schefferville. Later Baragar (1967) and Frarey and Duffell (1964) extended the name so as to include all predominantly pelitic rocks below the Wishart south of 56° N.

The writer (1969) introduced the name Swampy Bay Subgroup for a predominantly pelitic unit above the Pistolet Subgroup north of 56°N. Later he followed the rocks of the Pistolet and the Swampy Bay Subgroup southwards and found that part of the Pistolet Subgroup were identical to a unit of dolomitic and sandy rocks northwest of Wakuach Lake mapped, but not named, by Baragar (1967). These rocks are below the Attikamagen. They are overlain by lithological equivalents of the Swampy Bay. The pelitic rocks of the Attikamagen that are directly below the Wishart in the west of the Labrador trough, on the other hand, are different. It is clear therefore that the Swampy Bay Subgroup corresponds to the lower part of the Attikamagen.

It was therefore decided to retain the terminology as it had been used by Baragar (1967) and Dimroth (1969). The Attikamagen has been subdivided in several formations and was therefore elevated to Subgroup status.

SWAMPY BAY SUBGROUP

The name Swampy Bay Subgroup has been proposed (Dimroth 1969) for a suite of predominantly pelitic rocks that overlie the Pistolet Subgroup north of 56°00'. The Swampy Bay Subgroup as defined (Dimroth 1969) correlates with part of the Attikamagen, but it is not its synonym.

The Swampy Bay has been subdivided into three formations in the west of the Labrador trough. These are:

1. The Hautes Chutes Formation: graphitic slate
2. The Savigny Formation: grey slate
3. The Otelnuk Formation: a flysch type slate-greywacke sequence

The two following formations occur in the east of the trough and will be formally introduced in the following pages:

4. The du Chambon Formation: graphitic slate, greywacke, and sandstone conglomerate
5. The Romanet Formation: dolomite conglomerate, grit and sandstone, graphitic slate.

HAUTES CHUTES FORMATION 300 feet ±

A horizon of graphitic slate ovelying the Uvé Formation has been named Hautes Chutes Formation (Dimroth 1969). The type locality is at the High Falls of Swampy Bay River, at lat. 56°06', long. 68°21'. Good outcrop of the formation was also observed southeast of Uvé Pond, and west of the southern bay of Otelnuk Lake. The formation is poorly exposed elsewhere. 15-30 feet of black, graphitic chert are at the base of the Hautes Chutes Formation. The main body of the formation is composed of strongly graphitic slate. The slate is commonly strongly cleaved and disintegrates into thin shards. A fine tabular lamination is commonly visible under the microscope in thin sections provided the slates are not too strongly metamorphosed and deformed. Most parts of the formation contain sufficient graphite to stain the fingers. Some pyrite is commonly present, and some layers were observed that probably contain more than 20 per cent pyrite. Gossan composed of slate shards cemented by iron oxides was observed at a number of localities on top of the formation, and occurs probable over highly pyritiferous slates.

Stratigraphic correlation: Contacts between the Hautes Chutes Formation and the underlying Uvé Formation are exposed east and west of the south Bay of Chakonipau Lake, where the structure is controlled by top determinations. The upper contact of the Hautes Chutes Formation is not exposed; relations at the High Falls of Swampy Bay River leave little doubt that the unit grades upwards into the Savigny Formation.

Depositional environment: The Hautes Chutes was deposited in a poorly aerated basin under anaerobic conditions. Undisturbed delicate tabular laminations only tenths of a millimetre thick indicate very slow water velocities, and low rates of sedimentation. The Hautes Chutes is a deposit of euxinic facies.

SAVIGNY FORMATION

A formation of grey, laminated silty slate overlying the Hautes Chutes has been named Savigny Formation (Dimroth 1969). The type locality is north and east of Savigny Lake (lat. 56°21', long. 68°51'). The Savigny Formation contains a several hundred feet thick member of alternating slate and quartz wacke in the Savigny basin. It is composed only of slate in the Otelnuk basin. Its thickness is in excess of 2000 feet in the Savigny basin, whereas the formation is less than 1000 feet thick west of Otelnuk Lake.

The Savigny slate is dark grey and weathers light grey. Tabular laminations as well as micro-crosslaminations are very common. The slate contains some 30 per cent of fine quartz silt. A few 1 inch beds of black, graphitic dolomite occur locally close to the base of the formation at the High Falls of Swampy Bay River west of Otelnuk Lake, but were not recognized elsewhere. Ankerite porphyroblasts are fairly common in the Savigny slate.

2-20 cm thick beds of black quartz wacke occur in a several hundred feet thick zone in the formation northwest and southeast of Savigny Lake. Graded bedding has been recognized. The quartz wackes consist of well rounded fragments of quartz, of fragments of chert, siltstone, calcareous siltstone, fine-grained dolomitic sandstone and of grey slate embedded in a black shale matrix rich in graphite. Bedding planes are not easily observed because the slates that are intercalated between the quartz wacke beds split along cleavage planes rather than along the bedding. It is therefore unknown whether beds show flute casts or other structures indicating flow directions.

Stratigraphic relationships: The relations at the High Falls of Swampy Bay River leave little doubt that the Savigny Formation grades into the Haute Chutes Formation below and into the

Otelnuk Formation above in the Otelnuk Lake area. In the Savigny Lake area the Savigny is unconformably overlain by the Wishart Formation at Goethite Lake, where sedimentary tops and structure are known.

The Savigny Formation thins from 2000 feet at Savigny lake to 1000 feet at Otelnuk Lake, i.e. towards the basin centre. It is overlain by the very thick Otelnuk Formation in Otelnuk basin. These relations suggest that the Savigny is, at least in part, a facies correlate of the Otelnuk Formation into which it grades to the east and upwards.

The quartz wacke member occurs relatively high up in the Savigny Formation. Individual beds of quartz wacke are only a few cm thick, whereas the quartz wacke beds of the Otelnuk Formation are generally between 10 cm and 1 metre thick. These relations also suggest that the quartz wacke member of the Savigny represents the distal end of one of the quartz wacke members of the Otelnuk Formation.

Depositional environment: Composition and sediment textures of the Savigny Formation suggest deposition in relatively deep water under quiet conditions. The quartz wacke member may represent the distal facies of turbidites that thicken and coarsen towards the east.

OTELNUK FORMATION

The Otelnuk Formation is a flysch-type sequence of alternating shale and quartz wacke beds. It is more than 3000 feet thick. Its type locality has been defined at the western shore of Otelnuk Lake, where the formation is reasonably well exposed. The Otelnuk overlies ca 900 feet of Savigny Shale in the Otelnuk Lake basin; it is absent in the Savigny basin, where the Savigny is over 2000 feet thick. It is believed that Otelnuk and Savigny are at least in part equivalent.

In the Otelnuk Lake basin the formation has been subdivided into four, gradational, members as follows:

4b. upper shale member: mainly shale, some quartz wacke

4a. laminated member: very well laminated shale and quartz wacke

3. quartz wacke member: mainly quartz wacke, some shale

2. lower shale member: mainly shale, some quartz wacke

1. shale-quartz wacke member: shale and quartz wacke in approximately equal proportion.

It is very likely that this subdivision is only of local value.

Petrography: The shales of the Otelnuk Formation are well laminated and silty. They contain some graphite; and are dark grey on the fresh surface and weather light grey. Laminations are tabular or they show flaser laminations. The laminae are very commonly distorted by synsedimentary deformation.

The quartz wackes are gray and commonly have a mottled salt and pepper texture due to the presence of numerous slate and chert fragments. Some slate fragments may be as much as 1 inch long. The quartz wackes are thickly bedded, the beds commonly more than 1 foot thick. They are rather homogeneous and massive. The fragments are not oriented parallel to the bedding plane. Many quartz wacke beds do not show laminations or other internal structures.

Olive green or brownish green fine-grained impure sandstones or quartz wackes are more common than coarse quartz wackes. These rocks do not contain macroscopically visible rock fragments. They are commonly laminated and show well developed cross-laminations and flaser bedding. Ripple marks were observed at the upper surface of sandstone beds in the laminated member. The fine-grained sandstones show a relatively well developed bedding parallel fissility. Phenomena of flow and of penecontemporaneous deformation were observed. Irregular marks of uncertain origin, loadcasts, and convolute laminations occur.

Microscopically the quartz wackes and very fine-grained impure sandstones are very similar, except for the finer grain size of the latter. As rock fragments are mainly in the larger grain sizes the impure sandstones are also somewhat depleted of rock fragments.

The fragments constitute ca 60-70% of the rock. They consist of quartz, larger sizes commonly quite well rounded, smaller sizes in splinters, of plagioclase, of several types of commonly somewhat graphitic shale, of siltstone, and of chert. The groundmass consists of green, very fine-grained chlorite and sericite. Authigenic dolomite rhombohedra occur in the matrix, in slate fragments, and less commonly in chert fragments and include the fine-grained graphite dust of the material they replaced. Authigenic plagioclase laths and muscovite tables are also common, whereas authigenic magnetite is rare.

Relatively pure open-fabric sandstone has been observed in the lower part of the formation. The sandstone consists of rounded quartz grains ca 1 mm. across set in an abundant matrix of fine quartz splinters. The matrix contains very little clay.

Stratigraphic correlations: The Otelnuk Formation grades into the Savigny Formation below at the High Falls of Swampy Bay River.

Depositional environment: Material content, sediment textures, and sediment structures suggest that the Otelnuk Formation may be a turbidite. The source area must have been underlain by coarse-grained sandstones, and probably contained shales and similar rocks from which the shaly matrix of the quartz wackes is derived. The thickness relations between the Otelnuk and Savigny and the facies of the Savigny (some quartz wackes are present higher up in the Savigny Formation at Savigny Lake, whereas quartz wackes are absent in the Savigny at Otelnuk Lake), suggest that the Otelnuk is the coarser grained equivalent of the turbidites in the Savigny Formation.

DU CHAMBON FORMATION

The name du Chambon Formation is proposed for a horizon of black slate with minor quartz wacke, including a 100 feet thick bed of sandstone conglomerate between du Chambon and Romanet Lakes. The type locality is east of du Chambon Lake, at lat. 56°21', long. 67°59'. The du Chambon Formation conformably overlies the Uvé Dolomite; its top is not exposed.

The lower member is composed of graphitic slate, and dark grey laminated siltstone with a few 1 foot beds of grey, brown weathering dolomite in the area north of du Chambon lake. The dolomitic beds are absent between du Chambon lake and Romanet lake. Few beds of fine-grained graphitic quartz wackes are present in this zone. The formation consists of 1-6 feet thick beds of very fine-grained graphitic greywacke with 4 inches-2 feet interbeds of graphitic slate in the area northeast of Duvic bay.

The upper member is a grey, light rusty brown weathering, slightly dolomitic quartzite with nodular structure in the area between du Chambon and Romanet lakes. This nodular quartzite is believed to be derived from a conglomerate with sandstone fragments. The matrix between the sandstone fragments contains a little more dolomite than the fragments, which causes a nodular weathering of the rock. The sandstone conglomerate also contains some siltstone fragments. It contains irregular pockets of brown weathering dolomite in the area northeast of Duvic bay.

Petrographically the rocks of the du Chambon Formation are similar to those of the Savigny and Otelnuk Formations described on pp. 89-93. The shale and the matrix of the quartz wackes are rich in graphite; the rocks are therefore quite dark.

<u>Correlation</u>: The contacts between the du Chambon and the Uvé Formations are well exposed at the type locality, and northeast of Duvic bay. Sedimentary top determinations permit to control the structures at both localities. There is therefore no doubt that the du Chambon Formation overlies the Uvé Formation. The facies variation observed within the rather restricted area of the du Chambon Formation suggest that it may grade into the psammitic rocks of the Romanet Formation within short distances from the last

observed outcrops in the east. The correlation between du Chambon and Romanet Formations is therefore likely, but is not definitely established.

ROMANET FORMATION

The term Romanet Formation is here introduced for a unit characterized by an assemblage of dolomite conglomerate, graphitic greywacke, graphitic greywacke conglomerate, and graphitic slate. It is defined at lat. 56°22', long. 67°50' south of Romanet river. The Romanet Formation occurs only south of Romanet river, between longitudes 67°48' and 68°00'. Lack of outcrop did not permit separation of Romanet and Lace lake Formations in the area west of long. 67°53'.

The sequence exposed in the type area is as follows:

4. graphitic slate
3. graphitic greywacke and graphitic greywacke conglomerate
2. graphitic slate
1. dolomite conglomerate

The grain size of the rocks of the Romanet Formation decreases rapidly to the west. The dolomite conglomerate is present only east of long. 67°53' and graphitic slates and medium-grained graphitic greywackes predominate farther west. Lack of outcrops prohibits to determine the stratigraphical sequence of the western occurrences of the formation.

Petrography: The dolomite conglomerate is composed of blocks, up to 1 metre across of dolomite and of dolomitic sandstone set in a fine to medium grained sandstone matrix. Fragments of siltstone and shale, and quartz grains up to 1 cm across are common. The sandstone matrix is recrystallized to a mesh of quartz, with some interstitial chlorite.

Graphitic conglomerates have a characteristically open fabric of coarse quartz pebbles 1 cm across, and of fragments of siltstone and shale set in a fine-grained paste composed mainly of quartz with 10-15 per cent chlorite and sericite. Graphite dust is concentrated in the quartzose paste.

The slates are generally laminated on a mm-cm scale. They contain considerable graphite. Two cleavages are generally present, and locally three cleavages, a slaty cleavage and two sets of strain slip cleavage were observed.

Quartz wackes are similar to those in the du Chambon Formation. Their matrix is rich in graphite.

Correlation: The Romanet Formation overlies the Lace lake Formation. It obviously does not correlate with the Alder and Uvé Formations, from which it is entirely different. The Romanet Formation is therefore certainly younger than the Uvé Formation.

The facies changes within the Romanet and the du Chambon Formations are analoguous: the grain size of the rocks of the du Chambon Formation at Duvic bay increases rapidly from southwest to northeast; the much coarser grained rocks of the Romanet Formation occur north of the last outcrops of the du Chambon. Both formations have some lithological similarities: they contain graphitic slates and graphitic quartz wackes. The writer believes therefore that there are some indications suggesting that the Romanet and du Chambon Formations may correlate. The Romanet Formation is therefore supposed to be the marginal equivalent of the du Chambon Formation.

SANDSTONES AND CONGLOMERATES OF THE SWAMPY BAY SUBGROUP

All sandstones and conglomerates of the Swampy Bay Subgroup show common features that have a great genetic significance. They always have an open framework - sandstones being composed of sand grains set in an argillaceous or, less commonly silty, matrix, conglomerates of rock fragments set in a matrix of moderately coarse sandstone. Unstable components are exclusively of sedimentary origin and comprise dolomite, dolomitic sandstone, dolomitic siltstone and chert. Volcanic fragments are absent. Stable components are dominated by well rounded quartz of about 1 or 2 mm. average grain size. Feldspar is a relatively subordinate component. The unstable components of the conglomerates are easily destroyed on transport; the quartz wackes of finer grain sizes consequently are dominated by the stable component fraction. The shale matrix is either a normal grey shale (with small graphite content), or a strongly graphitic shale. Shale chips, identical to shale alternating with the sandstone beds, are a characteristic component of all coarser grained sandstones and of the conglomerates of the Swampy Bay Subgroup.

These features indicate that the sandstones and conglomerates of the Swampy Bay Subgroup are derived from a sedimentary terrain, composed of unmetamorphosed sandstones, dolomites and shales. Metamorphic and volcanic rocks were not present in the source area. The rocks of the source area were rapidly eroded and were probably transported to the site of deposition by turbidity currents.

Some sandstones in the Alder and Uvé Formations in the area northwest of Wakuach Lake, in the Swampy Bay equivalents of the region south of 56°00', and in the Bacchus Lake Formation have similar properties, and, in all likelihood are derived from a similar terrain.

ATTIKAMAGEN SUBGROUP

Harrison (1952) introduced the term Attikamagen Formation for a unit of red, green, and grey shale below the Denault Formation in the area west of Schefferville.

Later Frarey and Duffell (1964) and Baragar (1967) extended the unit so as to include all predominantly shaly rocks below the Denault, as well as volcanic rocks occurring in the east of the trough.

The Attikamagen, as defined by Harrison (1952) and Baragar (1967), was subdivided into several formations for the purpose of this report; therefore it is proposed to elevate the Attikamagen to Subgroup status. It is furthermore proposed to include the Denault Formation into this new subgroup for the following reasons: The Denault is overlain by shales that are indistinguishable from the Attikamagen in the area east and southeast of Schefferville. Farther east and southeast, along Ferrum River and at the southwestern shore of Attikamagen Lake, the Denault occurs only in the form of local dolomite lenses that are embedded within the Attikamagen Formation. The shales above the Denault therefore constitute an upper tongue of the shales of the Attikamagen Subgroup, and the Denault consequently constitutes a lentil separating two tongues of the Attikamagen. For similar reasons the Fleming Formation is also included in the Attikamagen Subgroup.

The Attikamagen comprises equivalents of the Swampy Bay Subgroup, and, higher up, five units of formational rank. Two of these will be defined and are named in this report. The sub-units of the Attikamagen are:

5. The Fleming Formation: chert breccia
4. The Dolly Lake Formation: red, green, and grey shale
3. The Denault Formation: dolomite
2. The Lac le Fer Formation: red, green, and grey shale
1. The Bacchus Formation: grey slate, impure sandstone, basalt and agglomerate

All these units have gradational and interfingering contacts. Their lithological types are well defined, but merge through imperceptible gradations. They are consequently difficult to map; poor outcrop in most areas underlain by the Attikamagen further complicates mapping. The writer did not attempt to remap the Attikamagen, and the different formations are separated only where they are clearly exemplified. All other localities are shown as unsubdivided Attikamagen.

SWAMPY BAY EQUIVALENTS

Equivalents of the Swampy Bay Subgroup were recognized in the area northwest, west, and east of Wakuach Lake. The Uvé Dolomite in this zone is overlain by black, graphitic slate that constitutes an equivalent of the Hautes Chutes Formation. Grey, well laminated shales with a few quartz wacke beds follow upwards and are regarded as equivalents of the Savigny Formation. Grey, impure, openwork sandstones and grits, quartz wackes and shales alternate in an area north and east of Wakuach Lake.

Graded bedding has been observed in this sequence (Baragar, 1967). The rocks overlie the Uvé Formation and represent an equivalent of an Otelnuk type sequence in a facies perhaps closer to the source area. They may be related to - lithologically similar - grits and conglomerates that are at the base of the Bacchus Formation at Cramolet, and Ribeiro Lakes. They have been mapped separately, wherever possible.

Petrography: The rocks of the sequence at Wakuach Lake are exactly like those in the Savigny and Otelnuk basins, except for the impure grit and sandstone northeast of Wakuach Lake. This rock contains an open framework of coarse, rounded quartz, little feldspar, with some fragments of chert and siltstone and shale, in a groundmass of fine- to medium-grained sand. Less than 10 per cent clay matrix is commonly present. Much of the rock is cemented by chert. Shale pebble conglomerate has locally been observed and is composed of shale fragments up to several an across set in a pelitic matrix.

Stratigraphic correlation: The "Swampy Bay equivalents" overlie the Uvé Formation northwest of Wakuach Lake and east of Ritchie Lake. Contacts are not exposed, but is in all likelihood unfaulted east of Ritchie Lake. Northwest of Wakuach Lake the Uvé Formation plunges below the "Swampy Bay equivalents". Sedimentary top determinations are available close to the contact between both formations at both localities. It is therefore most likely that the units discussed on page 100 correspond in fact to the Swampy Bay Subgroup.

The stratigraphic sequence within the "Swampy Bay equivalents" is not uniform. The unit is composed essentially of fine-graine pelitic rocks with subordinate quartz wacke in the area between Swampy Bay river and the Purdy Lake-Ritchie Lake depression. North and east of Wakuach Lake, on the other hand, coarse impure sandstone and grit overlies a relatively thin shale unit. These relations suggest, that a fine-grained pelites and quartz wacke suite grades eastwards and upwards into a coarsely clastic facies. These relations are analog to the relations between the Savigny and Otelnuk Formations north of lat. 56° N.

The relations between the "Swampy Bay equivalents" and the Lac le Fer Formation have not been studied in detail. "Swampy Bay equivalents" occur at the bent of Swampy Bay River at lat. 55°35', long. 67°43', and rocks of the Lac le Fer Formation occur below the Wishart and Denault Formation north and northwest of Lac le Fer. Folds in the district between Wakuach Lake and Lac le Fer appear to plunge generally to the SSE. This fact suggests that the "Swampy Bay equivalents" underlie the Lac le Fer Formation.

Depositional environment: Lithological similarities suggest an environment of deposition similar to the environment in which the Swampy Bay Subgroup has been deposited. The impure sandstones and grits northwest of Wakuach Lake however represent a more proximal facies of a turbidite sequence than the Otelnuk Formation.

BACCHUS LAKE FORMATION

The name Bacchus Lake Formation is here introduced for a unit comprising slate, impure sandstone, quartz wacke and basalts in the median and eastern part of the Labrador trough. The name is derived from Bacchus Lake, where the volcanic member of the formation is well exposed. The sedimentary parts of the formation are poorly exposed in this section, located at lat. 55°25' N., long. 66°55'W. The sedimentary members are much better exemplified between Otelnuk and Coussinet Lakes, at lat. 56°15' N., long. 68°05' W.

The relations at the base of the Bacchus Lake Formation are poorly exposed and are therefore poorly known. The formation overlies rocks of the Chakonipau, du Portage, or Lace Lake Formations. Because of exceedingly poor outcrops the base of the Formation is difficult to locate. Furthermore lithological contrast between the Bacchus Lake and Lace Lake Formations is small, which further complicates mapping of the boundary between both.

The formation is overlain by the Denault Dolomite south of 56°00', whereas a thick suite of basalts, named Mistamisk Formation, overlies it north of 56°15'.

Generally the Bacchus Lake Formation is vaguely subdivided in four indistinct members as follows:

4. Upper shale-sandstone member: grey shale, impure sandstone, locally little basalt and agglomerate
3. Main basalt member: pillowed or massive basalt, subordinate slate
2. Lower shale-sandstone member
1. Local basal sandstone or conglomerate

Some fifty sheets of medium- to coarse-grained basaltic rocks are intercalated between the sediments of members 1, 2, and 4 of the Bacchus Lake Formation. These have been shown as medium-grained basalts in the writer's preliminary maps (Dimroth 1964, 1965, 1967, 1969), whereas they were considered intrusive gabbro sills by Roscoe (1957) and Baragar (1967). Some of the gabbroic sheets, particularly at the base of the sequence have now been shown to be discordant. These are certainly intrusive rocks. Other sheets grade laterally into pillowed and massive basalts, and are therefore with certainty thick basalt flows. The writer now believes that the gabbroic sheets in the Bacchus Formation belong to a co-genetic extrusive-intrusive complex. Only in rare cases is it possible to prove the extrusive and intrusive nature of the gabbroic sheets.

The extrusive and intrusive varieties of the gabbroic sheets have the same petrography and petrology, and are therefore indistinguishable. It was therefore decided to describe them with the Montagnais Group below (pp. 168-194). They are shown as gabbro on the maps that accompany this report.

Basal member: The basal conglomerate of the Bacchus Lake Formation is well exposed at the northeastern shore of Cramolet Lake and at Ribeiro Lake. It consists of alternating beds, between 60 cm and 10 m thick, of coarse grey, locally pink, or red grit and conglomerate with pebbles, and blocks of grey, brown weathering dolomite and dolomitic sandstone. It is similar to the conglomerate of the Romanet Formation.

A conglomerate containing blocks, up to 30 cm across, of a pink dolomite derived from Dunphy type dolomites, in a matrix of green siltstone, is present at a small island of Ribeiro Lake. This conglomerate has been included with the Bacchus Lake Formation in this report. Its monomictic nature leaves open the option that it could belong to the uppermost part of the du Portage Formation, which occurs at the eastern shore of Ribeiro Lake. The dolomite conglomerate has been metamorphosed where it is in contact with gabbro, at the north shore of Ribeiro Lake. Baragar (1967) described the metamorphosed facies in great detail.

Grey grits were observed here and there between the Seward and the Bacchus Lake Formations in the area southwest of Cramolet Lake and northwest of Musset Lake. However the writers work has not been sufficiently detailed to clarify the stratigraphic relations at the base of the Bacchus Lake Formation south of Cramolet and Ribeiro Lakes.

Grey impure sandstone with interbeds of argillite are at the base of the Bacchus Lake Formation north of Dunphy Lake. It grades upwards into the laminated slate.

The lower clastics of the Bacchus Lake Formation generally overlie coarse clastics of the Seward. They are distinguished from those by their dark grey, or dark purple colours, by relative absence of feldspar, open fabric of clastic fragments, and by a subordinate but characteristic clay fraction.

It is relatively easy to locate the base of the Bacchus Formation in the few areas where the clastic member is present. Elsewhere the base of the formation is difficult to define with precision, particularly where it overlies the Lace Lake Formation. The separation is in part arbitrary on the accompanying maps, particularly northeast of du Portage Lake, and east of Romanet Lake. South of 56°00' all pelitic rocks overlying the du Portage have been included with the Bacchus Lake Formation. Poor outcrop does not permit to recognize the relations at the contact in detail.

Lower pelitic member: The basal sandstone, grit and conglomerate of the Bacchus Formation is overlain by grey laminated shale and siltstone with some beds of impure sandstone and quartz wacke. Few, thin, beds of grey, brown weathering, massive or brecciated dolomite occur northeast of Otelnuk Lake. Shale-in-shale breccia, and pelletoidal shale with graded bedding and with structures indicating syn-sedimentary deformation were observed at the base of the lower shale-sandstone member northeast of Cramolet Lake. Pillowed basalt and agglomerate locally occur in the lower member, particularly in the east of the area.

Main basalt member: The main basalt unit is composed of a few dozen flows of pillowed or massive basalt, between 10 and 60 feet thick. Some inches to a few feet of black, graphitic shale are locally between the flows. The member can be followed from west of Twisted Lake to Low Lake. It is approximately 2000 feet thick at Bacchus Lake. Equivalent basalt zones are present north of Dunphy Lake, northeast of Otelnuk Lake, and north of Romanet Lake.

Upper pelitic member: The upper slate-sandstone sequence follows on top of the main basalt. It is similar to those of the lower zone, but comprises considerably more sandstone. Impure sandstone and quartz wacke forms about one third or one half of the exposed rock close to the upper contact of the formation. Some dolomite beds, 4-6 feet thick, grey and brown weathering, occur below the main sandstone zone northeast of Otelnuk Lake. Dolomites appear to be absent elsewhere.

Basaltic rocks

Basalts compose a considerable part of the Bacchus Lake, Menihek, and Thompson Lake Formations and compose most of the Willbob Formation. All these basalts are lithologically indistinguishable and their petrography will be described in this chapter. The chemistry of the basaltic rocks will be discussed on pages 249-256.

The rocks shown as basalt on the maps accompanying this report are fine-grained or aphanitic. They form flows between 5 and 50 feet thick. Thicker flows are by no means absent; they crystallized to coarse-grained gabbroic rocks. The thick flows are therefore shown as gabbro on the accompanying maps, and are described with the Montagnais Group because it is generally impossible to separate the extrusive gabbroic rocks from lithological equivalents that have an intrusive origin.

Massive basalt flows, about 20-50 feet thick are most common in the Bacchus Lake and Menihek Formations. The flows are separated by a few inches of shale at many localities. A few inches of hyaloclastic material are very commonly at the top and locally also at the base. Grain sizes vary from less than 0.1 mm close to the contact to about 1 mm in the centres of flows exceeding 30 feet in thickness. Columnar jointing is common in massive flows.

Partly pillowed flows were observed at Coussinet Lake and at lac Aubin. They are between 20 and 50 feet thick. Partly pillowed flows are massive in the centre, whereas their tops and, less commonly, base have pillow structures. Not uncommonly the massive flow centres show columnar jointing. Grain sizes in the massive zones can be up to 1 mm, whereas the pillowed portions are very fine-grained or aphanitic. Some dm of hyaloclastic basalt breccia is generally at the base or at the top. The partly pillowed flows grade laterally into massive flows on the one hand, and into pillowed flows on the other.

Hyaloclastic rocks occur at the top and locally at the base of massive or pillowed basalt flows. Larger masses of hyaloclastic basalt have been mapped southeast of Romanet Lake, and south of Low Lake.

Massive basalts are dark grey on the fresh surface and weather light greenish grey. Aphanitic varieties contain fine plagioclase microlites, up to 0.2 mm long that are often forked and hollow. Some varieties contain plagioclase phenocrysts up to 2 cm long and 0.5 mm thick. The phenocrysts are set in a very fine-grained groundmass composed of pyroxene, plagioclase with some chlorite, clouded by finely distributed sphene. Relatively coarse-grained varieties have ophitic textures. Glomeroporphyritic basalts occur in the Menihek and Willbob Formations, and contain plagioclase aggregates up to 2 cm across, loosely set in an aphanitic or fine-grained basalt matrix.

Pillowed basalts are always fine-grained or aphanitic. Generally the pillow are surrounded by black crusts of hyaloclastic material, but in some cases they fit closely virtually without interstitial material. Interstices between pillows are often filled with black, chertified slate. In many flows the pillows contain parallel tabular cavities that are partly filled with quartz.

Hyaloclastic rocks range from pillow breccias to hyaloclastite in the strict sense. Typically the facies at the boundary of massive or pillowed flows contains small flat pillows, up to 50 cm long and 10 cm thick, and spherical "mini-pillows" up to 5 cm across, as well as their fragments, set in a matrix composed of devitrified glass shards that are partly welded and cemented by glass of different textures. Hyaloclastites sensu strictu lack the pillows and pillow fragments. The hyaloclastites are composed of generally undeterminable fine-grained material dusted by a cloud of finely dispersed sphene. Chlorite and epidote patches, and amygdules or veins filled with calcite, chlorite and/or epidote are common. Plagioclase phenocrysts up to 5 mm long are not uncommon.

Gradations of basalts into gabbroic rocks have been observed at Coussinet Lake and at Lac Aubin. At Lac Aubin massive basalt flows of gabbroic grain size, separated by hyaloclastic zones grade laterally first into partly pillowed basalt flows and within a lateral distance of about 2000 feet, in completely pillowed basalts.

Southeast of Coussinet Lake a unit composed of a gabbro sheet overlain and underlain by massive and partly pillowed basalt flows has been mapped. The thickness of the gabbro sheet and the aggregate thickness of the basalt flows vary inversely so that the total thickness of the sequence remains constant. Just south of Coussinet Lake the gabbro sheet lenses out to the west. The lower and upper contact of the gabbro sheet are well defined, but their lateral contact is gradational. It has been suggested (Dimroth 1971) that the basaltic flows erupted from the front of a thick flow. Similar relations appear to exist at localities northwest of Romanet Lake and south of Low Lake in the Bacchus Lake Formation, and east of Lac Aubin, in the Menihek Formation. They suggest that part of the gabbroic sheets in the Labrador trough are extrusive and are integrating part of the volcanic-sedimentary formations, between which they are intercalated.

The basalts of the Bacchus Formation are slightly metamorphosed in the area north of 56° and the Willbob

Basalts are generally somewhat metamorphosed. Their textures and structures are however well preserved. The meta-basalts are composed of a very fine-grained mesh of actinolitic hornblende, albite, epidote clouded by sphene, and contain minor ilmenite or magnetite, chlorite and calcite.

Basalt tuffs: Metamorphic basalt tuffs were observed at a number of localities within the Doublet Group and as well at some localities within the rocks of the Knob lake west of Romanet lake. They form layers of 10 to 50' thickness parallel to the bedding of the sediments.

The tuffs are light green or dark green, fine-grained, chloritic rocks. Schistosity is well developed. Calcite veins and lenses are common. The texture is inhomogeneous. Chlorite is present as eyes set in a very fine-grained matrix of chlorite, albite, clinozoisite, quartz and leucoxene. The shapes of plagioclases may occasionally be outlined by clinozoisite aggregates, although the albitized plagioclases themselves have been granulated. Relicts of plagioclase laths are rare. Calcite forms ameboid porphyroblasts and grains within the groundmass and separate eyes or veinlets.

Metamorphosed equivalents of the Bacchus Lake Formation

The pelitic and basaltic rocks of the Bacchus Lake

Formation are strongly metamorphosed in the northeast of the Romanet Lake area. Four rock types are prominent:

1. Dark grey to black fine- to medium-grained biotite-muscovite schists
2. Dark grey or black fine-grained biotite-garnet schists
3. Black biotite-amphibole schists
4. Grey, white weathering biotite quartzites
5. Chlorite schists

The type (1) occurs in the western part of the metamorphosed area. It is composed of biotite, muscovite, and quartz with minor apatite, epidote, zircon and opaque minerals.

The biotite-amphibole schists and biotite-garnet schists and biotite-amphibole schists are devoid of muscovite. They commonly contain considerable graphite.

Deep brown or red brown biotite forms large xenomorphic and somewhat poikiloblastic porphyroblasts. It is undeformed. Graphite inclusions still trace the schistosity of the groundmass. The rim of the biotite is commonly free of graphite.

Dark blue green common hornblende is long nematoblastic. The crystals are zonar and the rims are commonly darker than their centres. Hornblende does not include much graphite.

Quartz forms angular or polygonal grains or grains elongated parallel to the schistosity. Feldspar is in minute granules which replaced the micaceous matrix of the phyllites and includes the graphite streaks. The feldspar granules are elongated parallel to the schistosity, and are too small for determination. They seem to be unoriented. Garnet forms more or less round poikiloblastic porphyroblasts. It includes numerous quartz grain which are frequently elongated and still trace the former schistosity of the rock. In many cases the garnets are rotated. Small xenomorphic grains of zoisite with graphite inclusions are a subordinate constituent. Apatite and zircon are accessory minerals.

The grey quartzites consist mainly of quartz, with some biotite and a little plagioclase. Quartz forms more or less polygonal grains, frequently elongated parallel to the schistosity. Biotite tables are oriented parallel to the schistosity. Commonly they contain some graphite which still show the lamination of the former slaty cleavage which may be oblique to the present schistosity of the rock. In this case it is assumed that the present schistosity of the quartzite is parallel to the fracture cleavage of the phyllitic rocks.

Chlorite schists derived probably from tuffaceous rocks occur east and south of Lac Préville. They consist of prochlorite, amphibole, albite, quartz, and the common accessory minerals. The chlorite schists are well laminated on a mm-cm scale.

Diagnosis of the Bacchus Lake Formation

The definition, delimitation and stratigraphic correlation of the Bacchus Lake Formation is one of the most complex problems of the area. As has been noted above the Bacchus Lake Formation is characterized by the presence of a prominent pillow basalt member (member 3, p. 124), entirelly absent from the other units of the Attikamagen Subgroup. The members 2 and 4 of the Bacchus Lake Formation also contain at a few places thin flows of pillow basalt or of basaltic hyaloclastite. 10-100 feet thick beds of these members are intercalated between 50-500 feet thick stratiform sheets of basaltic composition and of gabbroic texture. As noted above many of these are thought to be extrusive; nevertheless it appears unsafe to imply the gabbroic sheets in a definition of the Bacchus Lake Formation, because their extrusive origin is disputed (cf. Baragar 1960, 1967; Dimroth, 1971).

The sedimentary parts of the Bacchus Lake Formation are similar to the Otelnuk Formation. The basal clastic sequence (member 1) of the Bacchus Lake is similar to Otelnuk equivalents north of Wakuach Lake and to the clastics in the Romanet Formation.

Nevertheless the sediments of the Bacchus Lake Formation are in some ways distinct: they contain a few beds of dolomite, particularly north of 56° N. latitude. The sandstones are generally cleaner and comprise fine-grained, rather pure, orthoquartzites to sub quartz wackes, rather than rocks with more abundant matrix component. However these distinctions are minor and the main characteristic of the Bacchus Formation is in the participation of basaltic rocks in the sequence.

Stratigraphic correlation: The rocks of the Bacchus Lake Formation overlie rocks of the Chakonipau, du Portage, Dunphy, and Lace Lake Formations. Rocks of the Alder and Uvé Formations occur east and west of the area underlain by the Bacchus Lake Formation in the area north of 56°00'. Rocks of both groups are in fault contact, but the relations in the Otelnuk Mistamisk and Romanet Lake areas nevertheless leave no doubt that:

(1) the Alder and Uvé Formations were once continuous across the Labrador trough in the area north of 56°00'. They are now absent from the area northwest and south of Dunphy Lake, where the Bacchus Lake Formation overlies rocks of the Chakonipau, du Portage, Dunphy, and Lace Lake Formations.

(2) That the Bacchus Lake Formation was once continuous over the fault wedge of the Mistamisk-Romanet valley, now

underlain by rocks of the Alder, Uvé, du Chambon and Romanet Formations.

Consequently there can be no doubt that an erosional unconformity separates the Bacchus Lake Formations from the rock units below. This erosional unconformity is present at least in the median part of the trough (between Otelnuk and Romanet Lakes), north of 56°.

Facies considerations (outlined in the chapter on Historical geology) suggest that the quartz wackes of the Otelnuk Formation and of analogous units (du Chambon and Romanet Formations) are derived from source areas located in those areas where an erosional unconformity between the Bacchus Lake Formation and its base exists. This fact, and the lithological contrast between the Bacchus Lake Formation and the Otelnuk Formation suggest that the Bacchus Lake Formation is essentially younger than the Otelnuk. It is noted however that the basal clastic sequence of the Bacchus Lake Formation, particular the conglomerates at Cramolet Lake, might in part correspond to proximal equivalents of the Otelnuk and Romanet Formations.

The Bacchus Lake Formation underlies the Denault Formation at Hearst Lake and Tait Lake. Consequently it is believed that the main body of the Bacchus Lake Formation is equivalent to the Lac le Fer Formation, and possibly to the highest parts of the Swampy Bay Subgroup. The basal clastics, and in particular their conglomeratic phase might have been deposited in local basins and might correspond to proximal phases of the Otelnuk and Romanet Formations.

LAC LE FER FORMATION

The name Lac le Fer Formation is proposed for a unit of red, green, or grey, silty shale with poorly visible laminations. 5-10 cm beds of fine-grained sandstone and 1 foot beds and lenses of dolomite are common, subordinate, lithologies.

The type locality of the Lac le Fer Formation is defined west of Lac le Fer, at lat. 55°16', long. 67°25', where the formation is very well exposed. The formation grades eastward into rocks similar to the Savigny and Bacchus Lake Formations. Its gradation into the Swampy Bay equivalents, that are presumed to underlie the Lac le Fer Formation, has not been observed; the stratigraphic relations between both units are inferred from the structures southwest of Wakuach Lake and southeast of Purdy Lake. The Wishart Formation sharply overlies the formation in the west of the trough. In the area between Lac le Fer and Schefferville the Formation is overlain by the Denault Dolomite; the contact between both units is generally sharp in outcrop, but appears to interfinger on a large scale.

The typical shales of the formation are green, red, or grey; the colour changes rather erratically within short distances. On the whole red and green varieties predominate west of Lac le Fer, west of Annabel Lake and of Lac Vacher, whereas grey varieties occur at Helluva Lake, at Schefferville and east of Lac Vacher and Annabel Lake.

The shales of the Lac le Fer Formation are distinguished from those of the Swampy Bay Subgroup and of the Bacchus Lake Formation by the constant presence of a relatively coarse silt component. Laminations are produced by very small compositional variations; the pure shale laminae free of silt that characterize the Swampy Bay Subgroup or the Bacchus Formation are absent. The laminations are therefore poorly visible, except in the variegated varieties, where they are emphasized by red and green pigmentation of alternating laminae. A second distinction to the slates of other sub-units of the Attikamagen is in the nearly constant presence of a few per cent of carbonate.

Tabular lamination of a mm-cm scale are common in the formation; clay pebbles have been observed but appear to be an exceptional feature. Generally the bedding features are not well displayed in outcrop because they are due to minute compositional differences.

Very fine-grained and fine-grained red, green, yellow, or grey sandstone beds, 5-20 cm thick, occur in all sections of the Lac le Fer Formation. A few beds of medium-grained sandstone have also been observed.

Layers and lenses of dolomitic shale, shaly dolomite or dolomite occur commonly in the upper part of the Lac le Fer Formation. Dolomitic shales and shaly dolomites, are light grey, green, or red coloured. They have fine tabular laminations on a mm-cm scale. Cross-laminations are rare. Dolomite laminae are generally grey and weather brown. Lenses and beds of pure dolomite are either well laminated, or they recrystallized to a massive rock with chert concretions and quartz veins.

The Lac le Fer Formation grades eastwards into grey laminated slates similar to the Savigny Formation, as they are exposed along Ferrum River.

Correlation and depositional environment: The stratigraphic correlation and depositional environment of the Lac le Fer Formation are discussed on pp. 152 ff.

DENAULT FORMATION

The Denault Dolomite has been defined by Harrison (1952) in the Schefferville region. Later Donaldson (1963, 1966) and Baragar (1967), included in the formation a homotaxial dolomite unit in the east of the trough. This unit does not appear to be continuous with the original Denault, as both zones are separated by an area where only lenticular dolomite bodies occur at that stratigraphic level.

Western area

The Denault Dolomite defined by Harrison (1952) occurs only in an area limited by Helluva Lake, Stakit Lake-Myrtle Lake, Ferrum River and Lac le Fer. It is absent from a 1-4 miles wide zone at the western margin of the trough. The formation interfingers with the Lac le Fer Formation toward the west, and with the Dolly Lake Formation toward the east. Its thickness increases rapidly from west to east and attains a maximum perhaps exceeding 1000 feet west of Ferrum River. East of Ferrum River the Formation lenses out very rapidly.

Four facies zones have been outlined in the western area: (1) laminated dolomite and subordinate dolomitic sandstone alternate with minor interbeds of red and green siltstone, shale, and fine grained sandstone in the west, between Helluva Lake, Partington Lake, and Elizabeth Lake. (2) Very coarse intraclastic breccias and conglomerates alternate with laminated dolomite and subordinate dolomitic sandstone in the zone between the western shore of Lac le Fer and Schefferville. Some thin interbeds of red and green, locally grey, argillite, siltstone, and fine grained sandstone are present. (3) Intraclastic conglomerates of relatively fine grain (fragments generally less than 2 cm across) alternate with laminated shaly dolomite, and with prominent interbeds of grey shale in the zone between the east shore of Lac le Fer and the northwest corner of Attikamagen Lake. (4) Lenses of massive dolomite represent the formation east of Ferrum River.

Description: The laminated dolomites (zone 1-3, base of Denault in zone 4), are grey, fine-grained rocks. They commonly contain some argillaceous matter, particularly in zone 3. Laminae of silty, fine sandy and sandy dolomite are common, particularly in zones 1 and 2, and interbeds of medium to coarse grained dolomitic sandstone are present. Rhythmical laminations with first order laminae about 2-5 cm thick, and second order laminae on a mm-scale are common. The laminations are commonly tabular. Cross-lamination, contorted bedding, convolute lamination, and synsedimentary faulting are common.

Coarse intraclastic breccias appear to form from horizons showing synsedimentary faults. It appears that partly consolidated horizons began to slump down a slope. The lithified beds were fragmented, and were embedded in a fine calcareous mud derived from beds that were still in a semi-liquid state. From west to east the following sequence of intraclastic rocks appears to be developed:

par-autochthonous intraclastic breccias → allochthonous intraclastic breccias → allochthonous intraclastic conglomerates (Dimroth 1971b)

Breccias that apparently formed nearly in place have been observed on the ridge immediately west of Knob Lake. The breccia beds are up to 10 or 15 m (30 or 45 feet) thick. The base of the beds more or less follows bedding planes, but is locally transgressive. Synsedimentary faults in laminated dolomites below the breccia are filled with micrite mud identical to the matrix of the breccia. The breccia is composed of large, angular dolomite fragments up to 30 x 300 cm in size. Very large fragments are rotated not more than 30 degrees and occur commonly at a particular level of the intraclastic bed. The matrix between the fragments is composed of a fine calcareous groundmass containing intraclasts of all sizes. The top of the bed is a depositional surface; a thin cross-laminated zone generally follows on top of the intraclastic breccia. The breccias alternate with laminated dolomite. Some interbeds of green and red variegated siltstone, and of medium grained sandstone are present. Some of the intraclastic breccias contain sand, and fragments of sandstone.

The par-autochthonous breccias appear to grade laterally into conglomerates and breccias that evidently suffered transport. The breccias and conglomerates west and southwest of Knob Lake are very coarse grained; occasionally they contain fragments 100 cm long, and sizes of 10-20 cm are common. The beds are up to 10 m thick, 3-5 m are common. Erosional wash-outs are not uncommon at the base of the beds. The conglomerates grade abruptly into laminated dolomite at the top, often with crossbedded zones close to the top of the conglomerate bed. Conglomerates have grain sizes up to 5 cm, commonly of 1 cm or several mm in the area between Lac le Fer and Attikamagen Lake. Fragments of shale and of chert are not uncommon. Bed thickness ranges from several cm (inches) to about 1 m (3 feet). The base of the conglomeratic beds is commonly wavy, the top more or less abrupt. Poorly developed graded bedding occurs. Crossbedded zones are not uncommon above conglomeratic beds, and some of the crossbedded zones contain abundant small intraclasts. The conglomerates alternate with laminated dolomite, and with grey shale.

Laminated dolomites and intraclastic conglomerates contain fine- to medium-grained sand at many localities, and some beds are dolomitic sandstone. 1-10 cm thick interbeds of green and red silty shale are common in zone 1 and in the west of zone 2; they grade eastward in thin interbeds of grey silty shale. In the east of zone 3 about 30 per cent of the formation is composed of shale in 1-300 cm thick beds. Laminated dolomites in zone 3 are shaly, and alternate with grey shale.

Chert concretions are very common. Silicification of dolomites has been observed in the following forms: (1) Replacement of silica in irregular patches; internal textures in chert trace bedding planes across the silicified material. (2) Ovoidal nodules with concentric textures. Some nodules are made of concentrically laminated chalcedony; their core is occasionally filled with coarse-grained quartz. These are evidently fillings of solution voids. (3) Streaks with irregular shapes, fillings of cracks, and replacement around cracks. (4) Chalcedonic fillings of veins; the interor of veins is filled with coarse-grained quartz. (5) Lensoid layers, that commonly branch and bifurcate. (6) Replacement of shale chips. It is evident that silicification did not only proceed by replacement; a part of the silica in the Denault Formation is a filling of secondary solution porosity.

Eastern area: A dolomite unit homotaxial with and equivalent to the Denault Formation occurs in a narrow zone extending from Marion Lake in the south to Lac d'Argent in the north (Donaldson 1963, 1966, Baragar 1967). In the present area the formation occurs in three facies.

The eastern Denault is composed of a chert laminated fine-grained grey dolomite alternating with massive dolomite at d'Oiseaux Lake. The laminations are somewhat contorted. Farther north grey stromatolitic dolomite alternates with chert laminated dolomite showing strong synsedimentary deformation and with intraclastic dolomites. Beds of coarse brown weathering dolomitic sandstone and of sandy dolomite are intercalated between the stromatolitic and the chert laminated facies at Lac d'Argent. Donaldson (1963, 1966) and Baragar (1967) described the stromatolitic facies in detail.

DOLLY LAKE FORMATION

The Dolly Lake Formation has been introduced by Harrison et al. (1972). It is composed of black, grey, green, and red shale, sandstone and siltstone. The unit overlies the Denault Formation and underlies the Fleming and/or Wishart Formations. The Formation occurs only in the west of the Labrador trough, south of latitude 55°15'. It grades eastwards into grey shales with sandstone interbeds.

The Dolly Lake Formation is subdivided in two members, a lower black slate member, and an upper member composed of red and green siltstone, sandstone and shale. The lower member occurs only in the Squaw Lake anticline; it interfingers with and overlies the Denault dolomite. The upper member is present in the zone east of Schefferville where it is represented by fine-grained sandstone and siltstone. Toward the northeast end Attikamagen Lake the upper member grades into red and green siltstone and shale. It passes rapidly into grey shales that occur east of Ferrum river at the same level; according to maps by Iron Ore Company of Canada the Formation also passes into grey shales to the southeast, along the shore of Attikamagen Lake.

The lower member of the Dolly Lake Formation is very well exposed in the railway cut 1 mile south of Schefferville. It is composed of black and grey laminated slate, with 10-30 cm interbeds of medium- to coarse-grained sandstone and quartz wacke. Beds and lenses of intraclastic and laminated dolomite, up to 6 m thick, are characteristic intercalations. Beds of black chert are intercalated. The shales show tabular lamination; convolute lamination is common and bedding is not uncommonly disturbed below beds of intraclastic conglomerate. The beds of intraclastic conglomerate pinch and swell and are boudinaged. They interdigitate with the shale.

The red and green sandstone and siltstone of the upper member are very well exposed along the road leading from Schefferville to the abandoned radar station east of Dolly Lake. They are well bedded and laminated. Tabular lamination and crossbedding are common. Green and red siltstones and shales with tabular laminations are very well exposed at the northwestern termination of Attikamagen Lake.

FLEMING FORMATION

The Fleming Formation was defined by geologists of Iron Ore Company of Canada and has been formalized by Harrison (1952) for a chert breccia. A large amount of work has been done on the formation, amongst others by Dufresne (1952), Howell (1954), Gross (1968), and Baragar. The Formation occurs in a relatively small area trending from Helluva Lake to Lac le Fer and Schefferville.

The Fleming Formation overlies the Denault Dolomite and is overlain by the Wishart Formation. Both contacts are well defined. The Formation consists of many rock types described in table 12. A 2-6 feet thick bed of dark greenish grey siltstone is generally at the base of the formation. This bed is probably equivalent to the "cherty argillite" of Howell (1954). It is massive or shows planar laminations. Some chert nodules and chert veins are generally present, and appear to merge with the chert of the overlying breccia. The breccia is vaguely subdivided in two, or three interdigitating zones: the lower part of the formation commonly has a siltstone matrix, and contains patches of wildly contorted "laminated" chert, of brecciated laminated chert, and of siltstone. The upper part of the formation consists of the chert breccia with sandstone matrix, and contains patches of chert cemented breccia and of sandstone. Dolomite cement is locally present at the top. It should be noted that these zones are not clearly separated, that rock types interpenetrate wildly, and that the subdivision is vague.

Many of the chert fragments are derived from the chalcedonic infilling of open spaces. Alternation of normal chalcedony (fibre elongation negative) with thin bands of length-slow chalcedony (fibre elongation positive) is common in the fragments of chalcedony. Fragments of vein fillings are common. Other fragments consist of micro-crystalline cherty quartz. The matrix is either a cherty siltstone or a medium to coarse grained sandstone.

Harrison (1952), Dufresne (1952), Howell (1954), Baragar (1967) and Dimroth (1971) discussed the origin of the breccia. It was first regarded as a residual clastic deposit. However Howell (1954) recognized that much of the chert fragments formed and were fragmented in place. Howell also inferred from the contortion of the "laminated" chert of the formation that slumping must have played a great role in its development. Dimroth (1971) suggested that the Fleming has originally been deposited as a bedded unit, composed of alternating siltstone, sandstone and dolomite. Solution of dolomite and silicification took place before the cementation and lithefaction of the clastic constituents and produced chert nodules and the chalcedonic nodules and veins. The formation has been preciated and its constituents mixed by solution collapse and by slumping. This hypothesis has to be modified by the discovery of length-slow chalcedony, which indicates the former presence of evaporite minerals (Pittman and Folk, 1971). The writer now believes that solution collapse was more important than he originally implied, and that the Fleming chert breccia is, at least in part, an evaporite solution collapse breccia. However some slumping undoubtedly also occurred.

UNSUBDIVIDED ATTIKAMAGEN

The Attikamagen Subgroup has not been re-mapped for the purpose of the preparation of the maps accompanying this report, except where this was necessary for tectonic or stratigraphic reasons. Large areas underlain by the Attikamagen Subgroup are poorly exposed. It was consequently decided to indicate the presence of the sub-units

Table 12. Lithologies of the Fleming Formation

Arenites

1. Clayey siltstone. Dark greenish grey on fresh and weathered surface. Quartz grains about 0.05 mm, angular to subangular. Clay matrix 30-70 per cent. Silica cement. Much apatite.
2. Coarse-grained sandstone. Light grey on fresh and weathered surface. Quartz grains about 0.5-1 mm, well rounded. Silica cement.

Cherts

3. Massive replacement chert. Light grey, homogeneous; only present in one stratigraphic section 1.
4. Relict-textured replacement chert. Light grey chert with the relict texture of an intraclastic dolomite. Restricted to one stratigraphic section.
5. Laminated chert. 3-10 mm laminae of dark grey to black chert alternating with 5-20 mm laminae of clayey siltstone.

Breccias

6. Brecciated laminated chert. Shards of chert laminae embedded in clayey siltstone.
7. Chert breccia with siltstone matrix. Chert fragments (described below) embedded in clayey siltstone (type 1).
8. Chert breccia with sandstone matrix. Chert fragments (described below) embedded in sandstone matrix (type 2).
9. Chert cemented breccia. Chert fragments (described below) cemented by chert. Strongly recrystallized varieties may appear nearly homogeneous.

Chert Fragments

a) homogeneous chert. Sharp edged, angular fragments of milky white homogeneous chert.

b) chalcedonic nodules and amygdule coatings. Sharp edged fragments of laminated chalcedonic nodules and sharp-edged fragments of the coating of partly filled voids.

of the Attikamagen only at those localities where their presence has been verified by the writer, or where the composition has been well enough described by previous authors to permit subdivision.

All other areas underlain by the Subgroup are shown as unsubdivided Attikamagen. They are commonly underlain by grey or black laminated slates with or without beds of sandstone and quartzwacke.

CORRELATIONS AND DEPOSITIONAL ENVIRONMENT OF SWAMPY BAY AND ATTIKAMAGEN SUBGROUPS

Correlation and the interpretation of the depositional environment of the Swampy Bay and Attikamagen Subgroups pose complex problems. The arguments are reviewed here to some detail, although this repeats some of the discussions outlined in preceding pages.

Correlations

The Attikamagen and Swampy Bay Subgroups lack characteristic key beds. The correlations between the various formational sub-units are therefore by far less certain than in the Pistolet or Ferriman Subgroups. Furthermore outcrops in large zones underlain by the Swampy Bay and Attikamagen Subgroups is poor which further complicates mapping and stratigraphic correlation. Most formations are well defined only in certain areas, and grade into other formations laterally and vertically.

On the whole three facies zones can be distinguished in the present area. They are:

(1) A western zone between Castignon and Knob Lake, where the formations of the Swampy Bay Subgroup follow concordantly upon the Uvé Formation. The lower part of the sequence (Swampy Bay Subgroup and equivalents) are exposed of 55°30' but are likely continuous toward the south, below the younger stratigraphic units. The upper units of the Attikamagen, on the other hand, are absent north of 55°30', and have not been deposited north of 56°00'.

(2) A central zone where the Bacchus Lake Formation overlies with disconformable contact the formations of the Seward Subgroup, and locally, the Lace Lake Formation. The Denault Formation overlies the Bacchus Formation south of 56° but is absent farther north. This zone trends from Dunphy Lake to Tait Lake.

(3) The Romanet Mistamisk fault wedge, where only the Romanet and du Chambon Formations occur.

Western zone: West of Castignon Lake the graphitic slates of the Hautes Chutes are overlain by at least 2000 feet of the Savigny Shale; the latter unit contains a thin member of quartz wackes. Southeast of Chakonipau Lake, on the other hand, the Savigny Formation is devoid of coarse arenites and is less than 1000 feet thick. It is overlain by more than

3000 feet of the Otelnuk Formation that contains considerable quartz wacke. These relations were interpreted (Dimroth 1968) as indicating that the Savigny Shale grade upwards and eastwards into the coarsely clastic rocks of the Otelnuk Formation.

The same conclusion was reached in the area northwest of Wakuach Lake (Dimroth et al. 1970), where a considerable thickness of shale, siltstone and minor fine-grained greywacke overlie the Uvé Formation in the west. Farther east the finely clastic unit at the base of the Attikamagen I is thin. Grit, impure sandstone and quartz wacke beds, alternating with shale, follow upon this pelitic unit north of de Calonne Lake and southeast of Le Pas Lake. It appears therefore that predominantly pelitic rocks grade eastward and upward into predominantly psammites. The finely clastic units are believed to be equivalent to the Savigny Formation, whereas the coarsely clastic rocks probably are equivalent to the Otelnuk Formation.

South of Wakuach Lake folds generally plunge to the south-southeast. The Lac le Fer Formation underlies the area northwest and north of Lac le Fer that represents a higher structural level than the basin of Wakuach Lake, which is underlain by the equivalents of the Swampy Bay Subgroup. Therefore the writer assumes that the lac le Fer Formation overlies the Swampy Bay equivalents.

The Denault Formation grades toward the west into calcareous shales with dolomite lenses of the Lac le Fer Formation. It grades toward the east into the black and grey shales with dolomite lenses of the lower member of the Dolly Formation at Schefferville. At Attikamagen Lake the Denault Formation interfingers with shales and impure sandstones that are similar to the Bacchus Lake Formation. The Fleming Formation and the Dolly Lake Formations overlie the Denault Formation. The Lac le Fer, Denault, Fleming and Dolly Lake Formations occur only south of 55°30' in the west of the trough, and it is likely that they were not deposited north of that latitude.

Central zone and Romanet Mistamisk wedge: The Bacchus Lake Formation is in fault contact with the Romanet-Mistamisk wedge, where the Romanet and du Chambon Formations represent the Swampy Bay Subgroup. There can be no doubt the Bacchus Lake Formation was continuous over the Romanet-Mistamisk wedge. Consequently the Bacchus Lake must be younger than the Romanet and du Chambon Formations.

In the Hurst Lake-Chassin Lake valley the Bacchus Lake Formation underlies equivalents of the Denault Formation. Northeast of Attikamagen Lake, on the other hand, the slates and quartz wackes that overlie the main basalt member of the Bacchus Lake Formation interfinger with the Denault Dolomite.

Conclusions: On the whole it appears therefore that one can subdivide the Attikamagen Subgroup in two sub-units: (1) A lower sub-unit, comprising the Swampy Bay Subgroup and its equivalents, and (2) an upper sub-unit comprising the Lac le Fer, Denault, Fleming and Dolly Lake Formations in the west of the trough, and the Bacchus Lake Formation and the Denault Dolomite in the centre and east. Sedimentation continued after the deposition of the Pistolet Subgroup in the west of the trough, and in most parts of the Romanet-Mistamisk wedge. In the centre of the sedimentation was interrupted after deposition of the Pistolet. Subgroup, and some erosion occured before reviewed sedimentation began. Therefore the younger unit of the Attikamagen overlies the older Formations of the Pistolet Subgroup in this zone. The correlation of the Bacchus Lake Formation with other units of the Attikamagen Subgroup is quite imprecise, and the formation may well comprise equivalents of upper parts of the Swampy Bay.

Depositional environment

Swampy Bay Subgroup and equivalents: The coarsening of arenitic rocks of the Swampy Bay Subgroup in the Castignon and Otelnuk Lake areas toward the east suggests derivation from a source area farther east. Derivation from older Aphebian rocks is indicated by the presence of well rounded quartz, and of fragments of calcareous siltstone and chert in the quartz wackes. Volcanic fragments, on the other hand, are absent.

The writer (Dimroth 1968b, Dimroth et al. 1970) therefore implied that these rocks were derived from a central geanticline extending between Coussinet and Ribeiro Lakes. Some parts of the Otelnuk and Savigny Formations contain graded wacke beds; Bouma cycles have been observed in the Savigny. It is therefore possible that part of the material was transported by turbidite currents from the east into a relatively deep basin farther west.

Similar relations apparently existed north of Wakuach Lake, where pelitic rocks in the west appear to grade into coarse clastics to the east. The source of the clastics could be located in the area between Cramolet and Musset Lakes.

The conglomerates of the Romanet Formation are clearly derived from earlier Kaniapiskau rocks in the area northeast of Romanet River. Dimroth (1968) implied that they formed as slumped masses at the base of fault scarps that followed Romanet River. The rocks grade into greywackes and shales toward the southwest of the Romanet-Mistamisk wedge.

Bacchus Lake Formation: The Bacchus Lake Formation is composed of submarine basalt flows, graphitic shales, and impure sandstones. Deposition in a marine basin, in relatively deep water appears to be indicated. Graded bedding is uncommon; graded sandstones, shale in shale breccias, and dolomite conglomerates were observed northwest of Cramolet Lake, at the base of the formation,and may indicate local faulting at the beginning of its deposition.

Lac le Fer and Denault Formations

The depositional environment of both Formations has been discussed in detail by Dimroth 1971.

The Lac le Fer Formation is a red and green silty shale with sandstone beds in the west of the trough, and grades eastwards into grey silty shales. Tabular laminations are characteristic. It is suggested that the red and green marginal facies of the formation are a pro-deltaic quiet water deposit transported into the basin from the west, and grading into grey basinal shales eastward.

The western facies of the Denault Formation develops from the Lac le Fer Formation. Deposition in shallow quiet water has been inferred from predominant tabular laminations and from the predominant red and green colours of the inter-bedded shales that indicate an oxygenized environment. Traces of synsedimentary deformation indicate that the sedimentary interface was dipping eastward.

Toward the east the laminated facies of the Denault grades into intraclastic breccias and conglomerates. These probably contain all gradations between slumps and turbidites. It is likely that they indicate the presence of a slope toward the east. Between Lac le Fer and Attikamagen Lake the formation is in basinal facies, where conglomerates decrease eastwards and dolomites are increasingly replaced eastward by dolomitic shales.

In the Lac d'Argent-Chassin Lake valley the Denault dolomite was deposited in very shallow water, as indicated by stromatolites. The eastern part of the trough during deposition of the Denault has to be regarded as a slowly subsiding platform.

Fleming and Dolly Lake Formations

Both formations have been discussed in detail in Dimroth 1971. It has been inferred above that the Fleming is derived from a layered sequence of sandstone, siltstone, dolomite, and probably gypsum, that underwent silicification and whose components were brecciated and mixed by solution collapse and slumping. The primary rocks of the unit likely were deposited in moderately deep water on top of a slope. Down slope slumping was induced during chertification and dissolution of gypsum and dolomite beds of the sequence.

The lower member of the Dolly Lake Formation is a basinal equivalent of parts of the Denault. The upper member is similar to the Lac le Fer Formation and has been interpreted as a deltaic or pro-deltaic deposit prograded into the remaining basin from the west.

FERRIMAN SUBGROUP

The name "Ferriman Series" was originally introduced by geologists of Labrador Mining and Exploration Company for a unit of quartzite and iron formation that is intercalated between the predominantly shaly Attikamagen below and the shaly Menihek Formation above. The name was not used by the geologists of the Geological Survey of Canada, and therefore never gained formal acceptance. It is, however, a useful term, because the Ferriman rocks are distinct from the lithologies above and below. Rocks of the Ferriman furthermore occur as a rule in litho-tectonic units separate from the Attikamagen rocks and it is therefore practical to show them as one map unit on large scale maps. The Ferriman has been subdivided into a relatively large number of subunits that can be correlated over great distances. The formations of the Ferriman have been followed northward from the area to the northern end of the Labrador trough, and southwards across the Grenville front deep into the Grenville Province. The Ferriman therefore deserves special consideration for stratigraphical reasons, as it permits correlation on a regional scale. Very thick suites of cherty ironstones, finally, render the Ferriman of unusual interest from the economic point of view. The writer believes therefore that it is justified to revive the term and to formalize it as Ferriman Subgroup.

The Ferriman comprises the following three formations:

1. Wishart Formation: mainly sandstone and quartzite
2. Ruth Formation: shale, siltstone, commonly ferriferous

3. Sokoman Formation: cherty ironstones. The subdivisions of the Ferriman are shown in table 13 where they are also compared with the type stratigraphy established by Iron Ore Company of Canada.

WISHART FORMATION

The Wishart Formation was established by Labrador Mining and Exploration Company, and has been formally introduced by Harrison (1952). The formation is composed predominantly of sandstone with minor arkose, subgreywacke, grit, siltstone and argillite. Its lower contact is sharply defined. Geologists of Labrador Mining and Exploration Company have drawn the upper boundary at the upper contact of a distinct chert marker bed against shale. Harrison excluded this chert bed from the Wishart, whereas Baragar (1967) followed the usage of Iron Ore Company of Canada. At Goethite and Low Lake slate separates the Wishart sandstone from the chert. The writer therefore followed Harrison's precedent. It should be noted that gradational contacts between Wishart sandstone and the chert exist at other localities.

The Wishart Formation as here defined is not amenable to a consistent vertical subdivision of more than very local value. Lateral facies variations also keep within close limits. Generally the Wishart is composed of grey orthoquartzites, and subarkoses with local interbeds of siltstone in the western part of the trough. Grits and pebble conglomerates

Table 13: Subdivision of the Ferriman Subgroup

Luche Lake	Hematite Lake	Goethite Lake	Lac de la Concession
?	?	?	Menihek Formation
top not exposed	top not exposed	top not exposed	
upper silicate-carbonate ironstone	upper silicate-carbonate ironstone	?	upper silicate-carbonate ironstone
upper hematite ironstone	upper hematite ironstone	upper hematite ironstone	upper hematite ironstone
middle silicate-carbonate ironstone	middle silicate-carbonate ironstone	middle silicate-carbonate ironstone	middle silicate-carbonate ironstone 2)
lower hematite ironstone	lower hematite ironstone	lower hematite ironstone	lower hematite ironstone
Ruth siltstone	variegated cherty siltstone / Ruth siltstone	Ruth siltstone	Ruth siltstone
basal jaspilite	basal chert	basal chert	
Wishart sandstone	? / Wishart sandstone	shale / Wishart sandstone	Wishart sandstone

Remarks:

1) Geologists of Iron Ore Company of Canada subdivided the upper silicate-carbonate ironstone in several members: Grey upper iron formation, yellow upper iron formation, red upper iron formation, lean chert.

2) Previously called lower silicate-carbonate ironstone (Dimroth, P.R. 532, 571)

3) Grey and pink members indistinguishable at many places. The subdivision can be applied to part of the area between Schefferville - Partington Lake - Lac le Fer - Squaw Lake.

Table 13 continued

Ritchie and Apollon Lakes	West of Helluva Lake	Gillespie Lake	E of Helluva Lake
?	?	?	?
top not exposed	top not exposed	top not exposed	top not exposed
upper silicate-carbonate ironstone	upper silicate-carbonate ironstone	?	upper silicate-carbonate ironstone
hematite ironstone	hematite ironstone	hematite ironstone	upper hematite ironstone
			middle silicate-carbonate ironstone
			lower hematite ironstone
Ruth siltstone	Ruth siltstone	lower silicate-carbonate ironstone	lower silicate-carbonate ironstone
		Ruth siltstone	Ruth shale
basal chert	basal chert	basal chert	basal chert
Wishart sandstone	Wishart sandstone	Wishart sandstone	Wishart sandstone

Table 13 continued

Lac le Fer	Myrtle Lake	Knob Lake	Knob Lake (I.O.C.C.) (Stubbins, Blais and Zajac, 1961)	
Menihek Formation	Menihek Formation	Menihek Formation	Menihek Formation	overlying unit
upper silicate-carbonate ironstone	upper silicate-carbonate ironstone	upper silicate-carbonate ironstone	several subdivisions [1]	SOKOMAN FORMATION
upper hematite ironstone	upper hematite ironstone	upper hematite ironstone	upper red cherty	
middle silicate-carbonate ironstone	middle silicate-carbonate ironstone	middle silicate carbonate ironstone	brown cherty	
lower hematite ironstone	lower hematite ironstone	lower hematite ironstone	grey cherty[3] pink cherty[3]	
laminated jaspilite	laminated jaspilite	laminated jaspilite	red cherty	
lower silicate-carbonate ironstone	lower silicate-carbonate ironstone	lower silicate-carbonate ironstone	silicate-carbonate iron formation	
Ruth shale	Ruth shale	Ruth shale	Ruth shale	RUTH FORMATION
basal chert	basal chert	basal chert	basal chert	
Wishart sandstone	Wishart sandstone	Wishart sandstone	Wishart quartzite	WISHART FORMATION

with fragments of chert, shale, siltstone and, very locally, of dolomite were observed here and there. Subgreywackes play a more important role in the centre and east of the trough, although the pure sandstones predominate even there.

A dolomite bearing unit occurs at Goethite Lake in the middle of the Formation. Members composed of very fine grained sandstone and siltstone are present at Hematite Lake, and in much of the area south of Helluva Lake. These members are not very persistent. The thickness of the Wishart Formation ranges from about 100 to approximately 300 feet. Harrison (1952) noted that the Formation thickens from about 100 feet at Stakit Lake to about 160 feet at Schefferville. The formation is relatively thin, about 100 feet, at Goethite and Concession Lakes, whereas it is about 200-250 feet thick at Hematite Lake. The greatest thicknesses were noted at des Oiseaux Lake in the east of the Labrador trough. For more detailed accounts see Harrison (1952), Harrison et al. (1970), Gross (1968) and Baragar (1967).

Petrography: A medium to coarse grained sandstone is the dominant rock type of the formation. Quartz sandstone is composed of well rounded quartz grains and a subordinate (10 per cent or less) feldspar fraction (mostly microcline). Rounded grains, composed of chlorite (derived from glauconite?) are common in some parts of the formation. Shale and chert fragments are local components. Arkosic phases occur as lenses, and contain up to 30 per cent feldspar, with microcline predominating. Grain sizes of the sandstone vary between 0.5 and

2 mm; all gradations to grits, and to siltstones exist.

The sandstones are cemented by minor clay matrix, by chert, or dolomite, or recrystallized to orthoquartzite. Rocks with little clay cement are strongly compacted. Rocks cemented by microgranular chert by chalcedonic chert or dolomite have normal packing indices. Dolomite cement commonly shows an irregular distribution through the rock; dolomite cemented sandstones therefore have an irregular nodular pattern at the exposed surface. Not uncommonly cementation is by quartz overgrowth on the clastic grains. The varieties cemented by quartz or by clay minerals are converted to quartzite tectonites devoid of clastic relict texture in strongly deformed zones, whereas the dolomite cemented rocks may survive strong deformation.

Pebble conglomerates form 1 foot thick beds sparingly distributed through the formation. They are composed of quartz and feldspars, with minor and mixture of slate, chert, and chalcedony. Chert pebble conglomerates are common in the area between Helluva Lake and Schefferville. Cementation is as in sandstones.

The siltstones and argillites are grey, or greenish grey laminated rocks, composed of alternating beds of 5 mm thickness of shale, siltstone and very fine grained sandstone. A tectonic cleavage is not common in fine grained rocks.

Sedimentary structures are commonly well preserved: crossbedding in sandstones, cross-lamination and convolution in the fine grained phases. Quartz cemented sandstones are recrystallized to white, often light pink weathering, massive quartzites without relictic sedimentary textures in some strongly deformed zones; pelitic rocks may contain a cleavage.

Stratigraphic correlation: The Wishart Sandstone overlies the Archaean basement along the western margin of the Labrador trough. Toward the centre of the trough it overlaps the older Proterozoic sequence. It is on top of the Pistolet and Swampy Bay Subgroups in the area north of 56° N latitude, and on top of the various formations of the Attikamagen Subgroup south of that latitude. The relations suggest that an erosional unconformity exists at the margin of the trough, whereas the Wishart conformably overlies the Dolly Lake Formation, and possibly the Fleming Formation (Dimroth et al. 1970, Dimroth 1971b) in the center of the trough.

Sedimentary environment: The Wishart Formation was probably deposited in shallow water. Parts of the Formation may be lacustrine, although the major part is probably shallow marine.

RUTH FORMATION

The Ruth Formation was first introduced by geologists of Labrador Mining and Exploration Company. The name was formalized by Harrison (1952). The formation is a shale or siltstone intercalated between the Wishart Quartzite and the Sokoman Ironstone. Black, grey, or locally red chert is at the base of the formation. The contact with the overlying lower silicate-carbonate ironstone of the Sokoman is interfingering and the Ruth should properly be regarded as the clastic equivalent of the lower member of the Sokoman.

The Ruth is everywhere subdivided in a lower chert member and an upper shale or siltstone member. North of 56°N the formation is subdivided in three sub-units: lower chert or jaspilite, shale, and siltstone. Variegated cherty siltstone is a prominent member at the top of the formation at Hematite Lake.

The thickness of the Ruth Formation varies from less than 20 feet to about 200 feet. It is about 50 feet thick between Goethite and Helluva Lakes, and thickens to approximately 150 or 200 feet at Hematite Lake. Its thickness is below 20 feet at Lac le Fer, and about 100 feet between Schefferville and Attikamagen Lake.

South of Helluva Lake the formation is composed of a black, fissile, thinly laminated shale. It contains interbeds of black chert, and of laminated cherty silicate-carbonate ironstones. Beds 10 cm-100 cm thick, of a grey, commonly pyritized tuff occur in the area east and west of Schefferville, and at the northwestern bay of Attikamagen Lake. (Iron Ore Co. of Canada, private reports; Gross, 1968; Zajac, 1970).

West and north of Helluva Lake the Ruth is represented by greenish grey siltstone, that is generally massive, but locally shows relictic lamination. Cross lamination is common in this type. Some feet of laminated shale generally underlie the siltstone.

The black shale that constitutes the formation in the south of the area was not studied by the writer. According to Zajac (1970) it is composed of chlorite, quartz and orthoclase, sericite being absent. It has a high carbon content and contains some pyrite. Interbeds of silicate-carbonate ironstone and of graphitic chert are common in the area south of Helluva Lake. Tuffs that occur in the ridges east and west of Schefferville, and at Attikamagen Lake consist of fragments of a prophyritic trachybasalt composed of alkali feldspar chlorite and ore minerals embedded in a mass of chlorite, pyrite, and alkali feldspar. The fragments have diametres between 1 and 20 mm. Some tuff beds, according to Zajac (1970) show graded bedding.

According to Zajac (1970) a jasper bed 20-50 feet thick form the top of the Ruth Formation in a narrow zone west of Schefferville. The horizon has not been encountered in any of the sections visited by the writer. It has been described as a laminated jaspilite locally with intraclastic beds.

Petrography: The siltstones are dark, somewhat greenish grey, hard and tough rocks with conchoidal fracture. They are massive, or laminated on a scale of ca 5 mm. The lamination is faint and is produced by alternating slightly lighter and darker material. The rocks do not break parallel to this lamination.

The siltstone consists of ca 50% or more angular fragments of quartz with a maximum diameter of 0.05 mm. Much of the quartz grains has grain sizes about and possibly below .02 mm, and cannot be separated from the matrix under the microscope. The matrix is dark green and consists of a unresolvable mesh of clay or mica minerals and chlorite. Small eyes (diameter ca .05 mm) of chlorite, and rare 0.1 mm long thin tables of muscovite and biotite (?) are obviously authigenic minerals. A few rounded grains with sutured boundaries of potassium feldspar (diameter .05 mm) may be clastic or authigenic. The matrix contains ca 0.1 mm long slender opaque table (ilmenite, graphite?) and is full of opaque dust. Aggregate polarization is absent, and the matrix is nearly isotropic. A faint dimensional bedding-parallel orientation of the quartz grains and of the tabular crystals in the matrix was observed in the laminated variety, whereas the massive siltstone seems to be unoriented. The siltstones show no metamorphic changes whatsoever.

The <u>shales</u> are well laminated and consist of ca 5 mm thick dark grey pelitic beds alternating with ca 2-3 mm thick lighter grey silty beds. Pinch and swell structures and incipient boudinage of the silty beds are common. A bedding parallel fissility is prominent.

The silty beds consist of ca 80% recrystallized quartz grains with an interstitial matrix of chlorite. They are sharply bounded against the shale layers. The shale layers contain ca 30% quartz silt in angular fragments in a chloritic-micaceous matrix. The grain size is somewhat larger than in the siltstones described above. The same authigenic muscovite, biotite (?), and graphite (?) crystals and chlorite eyes were observed. Fine opaque dust is present. The tabular crystals as well as the mesh of the matrix show a prominent bedding parallel dimensional orientation.

The siltstones, and shales, occurring in the Luche lake-Girafe lake belt contain more iron than those in the Lace lake area. They therefore weather brown and contain brown or black manganese coatings on the fracture planes.

The black chert is somewhat wavy bedded and macroscopically homogeneous. Under the microscope it is seen to consist of intraclasts of 0.5-0.7 mm diameter. The intraclasts have an irregular outline with rounded boundaries. They are densely packed and consist of very fine-grained quartz (grain size below 0.02 mm) dusty with graphite. The quartz between the granules are larger. They are cemented by microcrystalline chert, by quartz with impingement textures, or by chalcedony. Locally the black chert grades into red laminated jasper and in red oolitic jasper. The petrography of the jaspers is described with the Sokoman Formation, pp. 172-191.

The variegated cherty siltstone show alternating green and red laminae several mm thick. The green laminae are composed of clay minerals into which are set sand size intraclasts of chlorite and of iron oxide. The surface of chlorite intraclasts are commonly oxidized and the iron oxide intraclasts are perhaps oxidized chlorite intraclasts. The red laminae contain angular quartz and feldspar fragments, chlorite intraclasts, and intraclasts of chert and of hematite. Intraclasts are strongly deformed through compaction. Clay pebbles are present.

Stratigraphic correlation: The Ruth Formation overlies the Wishart quartzite and underlies the Sokoman Formation. It grades laterally into the lower silicate-carbonate member. of the Sokoman which is absent northwest of Ritchie Lake.

Sedimentary environment: The environment of the Ruth Formation will be discussed with the Sokoman Formation.

SOKOMAN FORMATION

The name Sokoman Formation was introduced by geologists of Labrador Mining and Exploration Company for the main unit of cherty ironstones occurring in the Schefferville area. The name is not derived from a topographic name, but stems from the word "Sokoman" meaning "iron" in the Montagnais language. The name has been formalized by Harrison (1952). The writer work on the Sokoman Formation is not concluded and the following account is preliminary.

The Sokoman is a unit of cherty ironstones, essentially devoid of clastic material. Its lower boundary is here defined at the height where the predominantly fine clastic sedimentation of the Ruth gives way to exclusively chemical precipitates. The lower limit of the Sokoman is therefore a facies boundary, and the Ruth is the clastic equivalent of parts of the Sokoman Formation as outlined in table 13. The Menihek Shale overlies the Sokoman with an abrupt contact. Alternation of shale and iron formation has been observed at few localities at the upper contact of the formation. Chert pebble conglomerates have been described from other localities (Iron Ore Co. of Canada, private reports) and give evidence of brief local regression and a minor unconformity. A major disconformity is present above the Sokoman in the area north of 57° (Bergeron 1954, Fahrig 1957), where conglomerates with abundant pebbles of iron formation, shale, dolomite and gneiss overlie the Sokoman Formation. Within this area, however, the upper contact of the Sokoman appears to be essentially concordant and sedimentation was apparently uninterrupted at most places. The Sokoman is absent in the northeast of the area, either because it was not deposited, or because it has been eroded before Menihek deposition.

Vertical subdivision and facies variation

In the Schefferville area Blais, Stubbins and Zajac (1962) subdivided the Sokoman Formation in five members.

They can essentially be followed over the whole region. The typical subdivisions are shown in table 14. The reader should note that the term "ironstone" is used here instead of "iron formation" and that only strongly recrystallized rocks whose original composition is unknown are named "metallic ironstones" in this report, whereas the term "cherty metallic iron formation" is applied by other geologists to all those rocks containing bands of recrystallized magnetite and/or hematite. A more detailed descriptions of the Sokoman has been presented by Gross (1968), Dimroth (1968) Dimroth and Chauvel (1972), and Chauvel and Dimroth (in print).

Member 1 is a facies equivalent of the Ruth Formation. It is essentially absent north of Helluva Lake. It is a laminated silicate-carbonate ironstone in the centre and west-centre of the trough. Near the western margin the unit grades into poorly laminated or massive, cherty, intraclastic, silicate-carbonate ironstones.

Member 2 also varies considerably in aspect. The unit is represented by alternating beds, 2-5 cm thick, of laminated jasper, and of oolitic pisolitic and intraclastic rocks in the west of the trough. This facies is called thin bedded oolitic jasper. It grades eastwards in an alternating sequence of laminated jasper and laminated silicate-carbonate ironstone containing much magnetite, named here "laminated jasper". The member is absent north of 55°30'.

Table 14

Subdivisions of the Sokoman Formation

	Schefferville (Blais, Stubbins and Zajac, 1962)	Central Labrador trough (this report)
6	lean cherts, grey upper iron formation, and red upper iron formation 80' - 200'	upper silicate-carbonate ironstone
5	upper red cherty metallic iron formation 80' - 150'	upper hematite ironstone
4	brown cherty metallic iron formation 10' - 40'	middle silicate-carbonate ironstone
3	pink and grey cherty metallic iron formation 50' - 100'	lower hematite ironstone
2	red cherty metallic iron formation 30' - 60'	laminated jaspilite
1	silicate-carbonate iron formation, lower iron formation 30' - 100'	lower silicate-carbonate ironstone

Member 3 is a thickly bedded hematite ironstone that shows very strong textural variations. Member 4 is generally present in the area north of 56° and in the Helluva Lake-Lac le Fer area. It is missing at Ritchie Lake. At Schefferville the member does not appear to be well developed. Properly the unit is composed of laminated or intraclastic silicate-carbonate ironstones, but in many localities is represented only by a horizon containing carbonate lenses in pink hematite ironstones.

Member 5 is thick bedded hematite ironstone that in many places contains lenses and layers of homogeneous jasper. Member 6 was rarely seen by the writer. It is generally described as greenish grey or light pink lean chert. Local facies are ferriferous shale (yellow upper iron formation), magnetite greywacke, and reduced or well preserved hematite ironstones (grey and red upper iron formation).

The total thickness of the Sokoman Formation varies from perhaps 250 feet to over 500 feet. Thicknesses of 800 feet have been reported from the eastern Labrador trough (Baragar, 1967).

Petrography

The reader is referred to papers by Dimroth (1968) and Dimroth and Chauvel (in print) for detail concerning the petrography of the ironstones. Members 1, 4, and 6 of the

Sokoman are composed of three essential rock types: laminated minnesotaite-siderite ironstone, intraclastic minnesotaite-siderite ironstone, and black or grey chert. The minnesotaite-siderite ironstones are dark greenish grey, or dark olive green on the fresh surface; they weather in various shades of brown, or in bright orange colours; siderite rich rocks generally weather brown, minnesotaite rich beds weather bright brick red. They are composed of minnesotaite, stilpnomelane, siderite, ankerite, magnetite, and cherty quartz in varying proportion.

Varieties showing tabular compositional laminae on a scale of 1 mm-1 cm are most common. The laminations are generally produced by a variation of the quartz content, whereas the predominating iron mineral remains generally the same over a larger thickness of the rock. Alternation of minnesotaite rich and siderite rich laminae was less commonly observed. Laminae rich in magnetite occur here and there, and are probably an analogon to the "metallic" veins of the hematite ironstones. 1 cm-3 cm thick laminae of black chert are commonly interspersed with the laminated minnesotaite-siderite ironstones. Structures indicating pene-contemporaneous deformation are common.

Intraclastic minnesotaite-siderite ironstones form 3-10 cm thick beds that alternate with equally thick beds of the laminated variety. They are composed of fragments of minnesotaite-siderite ironstone, between ½ mm and 5 cm across, set in a groundmass of the same composition. The fragments are finer grained and darker than the matrix. Boundaries are generally well defined, except where the rocks are recrystallized to relatively coarse grain sizes. Large fragments are discoidal, whereas small sizes area have spherical or ovoid shapes. The fragments are generally loosely set into the matrix, and some beds show only a few dispersed large fragments floating in the groundmass. Graded bedding has been observed.

Ferriferous chert generally forms beds that are at least several feet thick. It is dark greenish grey, or black on the fresh surface and weathers brown or grey. Cherty quartz is the only major constituent; magnetite, minnesotaite, greenalite and siderite occur in small quantity. Some varieties contain siderite concretions, 1 mm-6 cm across, or siderite lenses, up to 1 foot thick and 6 feet long. Intraclastic textures are commonly visible in the chert. They are generally not well preserved.

Much of the minnesotaite-siderite ironstone has been altered under conditions of near-surficial weathering, particularly south of 55°45'. Minnesotaite and siderite of the altered ironstones has been transformed to goethite or limonite and magnetite has commonly been replaced by magnemite and martite. The alteration particularly affects the ironstones in areas close to the height-of-land.

Thin bedded jaspilite is composed of beds, 1 cm to 20 cm thick, of finely laminated jasper with colours ranging from bright brick red through pink to pinkish grey. The beds pinch and swell and commonly lens out along strike after a few metres. Beds, 1 cm to several metres thick, of laminated silicate-carbonate ironstone, and beds, several cm thick of laminated, contorted bluish black ironstone rich in magnetite alternate with the jasper. The metallic beds are altered silicate-carbonate ironstones. They have a good bedding parallel fissility. Interbeds of oolitic, pisolitic and coarsely intraclastic hematite ironstone also are a characteristic component. The typical thin bedded jaspilite has been observed in the area between Partington Lake, Lac le Fer, Attikamagen Lake and Schefferville. It grades into a facies devoid of interbeds of the silicate-carbonate iron formation to the west and northwest. This facies is called the red cherty member in Schefferville by geologists of Iron Ore Company of Canada.

Cherty quartz, hematite and magnetite are the main constituents; minnesotaite and siderite are common minerals, and stilpnomelane and riebeckite were observed at a few places. Goethite is a common alteration product. Cherty quartz recrystallized to more or less polygonal grains ranging in size from submicroscopic to about 0.1 mm. Fine-grained patches some tenths of a millimetre across are generally set in a coarser, but very inequigranular matrix. Hematite occurs in two varieties: as dust particles 0.001 mm across, and as specularite with a grain around 0.03 mm. Magnetite forms well shaped octahedra about 0.03 mm across. Specularite and magnetite are commonly concentrated in small patches a few tenth of a millimetre across. The colour of the rock depends on its content of hematite dust, and of recrystallized specularite and magnetite. Laminae rich in hematite dust are brick red, and the intensity of the red colour decreases with content of hematite dust. Laminae composed essentially of specularite and magnetite are black or commonly bluish black.

The red cherty member is equivalent to the laminated jaspilite in the area west of Schefferville, and Lac le Fer. It is composed of alternating beds. 1-5 cm thick, of laminated jasper, as described above, and hematite ironstone with oolites, pisolites and intraclasts. Bluish black metallic layers rich in magnetite and hematite more or less parallel the bedding.

Thick bedded jaspilite is composed of 3 to 60 cm thick, grossly lensoid beds that commonly pinch and swell along strike. Some of the beds are laminated on a scale of several mm or cm. Gradations to thin bedded jaspilite occur, where thinly laminated beds constitute a significant portion of the rock. Colours range from brick red through pink to grey with a pink tinge. A profusion of bluish black "metallic" veins, commonly parallel to the bedding, pervades the rock. Their thickness varies between 1 mm and several cm. They are generally sharply bounded, although gradations from red jasper through pinkish grey jasper into metallic material are not uncommon.

Most of the thick bedded jaspilite shows inhomogeneous colouring and is densely packed with brick red jasper spots, between 1 mm and 5 cm across, set in pinkish grey or metallic groundmass. Beds or irregularly bounded patches in beds contain metallic spots set in a grey groundmass. The spots are commonly sharply bounded; they occasionally show diffuse boundaries, particularly where they are preserved as metallic material. Occasionally the spots are clearly identified as intraclasts, oolites or pisolites. They are not readily identified as such where the rock is strongly recrystallized, and particularly where they are preserved as metallic material.

More or less spherical iron carbonate concretions are relatively common in the thickly bedded jasper; less common are irregular lenses of iron carbonate in the rock.

Two varieties of the thick bedded jaspilite are commonly distinguished by economic geologists: "grey cherty metallic iron formation" and "jasper metallic iron formation". "Pink or grey cherty metallic iron formation" is generally coloured light red, pink, pinkish grey, or grey, whereas brick red jasper beds, between 3 and 5 cm thick, characterize the "jasper metallic" variety. Typical "jasper metallic iron formation" contains some 20 to 50 per cent of these brick red beds and lenses. Gradations between both varieties are common.

"Grey cherty metallic iron formation" composes most of member 3, and "jasper metallic iron formation" much of member 5.

Thick bedded jaspilite with carbonate lenses are common at the upper and lower contacts of the middle silicate-carbonate ironstone. They are light pink or grey, generally finely intraclastic rocks with brown weathering irregular carbonate lenses 1-5 cm thick and up to 100 cm long. Locally they represent the whole of the middle silicate-carbonate ironstone (member 4).

Sedimentary and diagenetic textures

Well preserved cherty ironstones show characteristic microtextures, that are similar to the microtextures of limestones (Dimroth 1968a, Dimroth and Chauvel 1972). The sedimentary textures are overprinted, and to varying degrees destroyed by textures due to diagenetic recrystallization and replacement. There are characteristic differences between the microtextures of cherts on the one hand, and of silicate-carbonate ironstones poor in quartzose material on the other.

Finely laminated silicate-carbonate ironstones show microtextures similar to micritic limestones. It is supposed that they were laid down as fine-grained iron-silicate and iron-carbonate muds. A second type of silicate-carbonate ironstone contains intraclasts set in a matrix of the same composition. The largest diametre of the intraclasts varies between 1 mm and 5 cm; large sizes are discoidal, whereas small intraclasts have ellipsoidal or spherical shapes. Large intraclasts are laminated, and are readily identified as fragments of the unconsolidated sediment that were redeposited. They are loosely set in a fine-grained commonly vaguely stratified matrix that is supposed to be derived from an iron silicate and iron carbonate mud.

These intraclastic rocks are texturally similar to limestone intramicrites. The term femicrite has been introduced to design the finely laminated variety, whereas the intraclastic rocks have been called intrafemicrites (Dimroth 1968a).

Chert beds are either homogeneous, or show fine streaky laminations. Other common types contain pellets, intraclasts, oolites, or onkolites (pisolites). Homogeneous beds and those with fine streaky laminations were presumably deposited as silicagel muds. Pellets are ellipsoidal bodies without internal textures between 1/10 and 1/2 of a mm across. They are loosely set in a chert matrix showing streaky laminations. Such rocks were called pelletoidal matrix chert; many of the homogeneous lookong jasper beds are of this type. It is believed that the pellets are flocculation units or larger aggregated units that formed drifting in sea water and that they were deposited together with silicagel mud that forms their matrix.

The long diametre of intraclasts vary between ½ mm and 5 cm. Large intraclasts are discoidal, whereas small intraclasts have more or less irregular ellipsoidal shapes. Large intraclasts generally contain pellet textures proving that they are fragments of pelletoidal matrix chert. Dessication cracks are common and some intraclasts are deformed. It is believed that intraclasts are redeposited fragments of unconsolidated or semi-consolidated generally pelletoidal matrix chert.

Ironstone oolites and pisolites are composed of a spherical core without internal texture that is surrounded by concentric skins of chert with variable hematite content. The core is quite commonly recrystallized. Shrinkage cracks are present in core and skin. The oolites and pisolites are occasionally deformed and may be extremely flattened parallel to the bedding. Oolites have diametres around 1 mm. Pisolites with diametres above 5 mm (onkolites) are probably of algal origin.

Intraclasts, oolites and onkolites of cherts are densely packed, and cemented by chert with low content of hematite dust in most hematite ironstones. Chalcedony oriented perpendicular to the component boundaries was observed at one locality as cementing medium. It is more commonly recrystallized to a relatively coarse-grained quartz mosaic with c-axes perpendicular to the grain boundaries. Both cases prove that the chert between the components is a cement that was introduced after the components had been deposited. More commonly, however, the chert cement recrystallized to a fine-grained chert distinguished from the components only by its somewhat larger grain size, and by the relative absence of pigmenting hematite dust. In other cases intraclasts, oolites and pisolites were embedded in a more or less homogeneous jasper matrix.

Diagenetic recrystallization and metasomatism destroyed the sediment textures to varying degrees. Reactions taking place during diagenesis and metamorphism are very complex and have been discussed by Dimroth (1968) and Dimroth and Chauvel (1972). The silicate and carbonate bearing cherts in particular are strongly recrystallized, and commonly contain only vague traces of pelletoidal or intraclastic textures. The dusty hematite pigment that outlines the sediment textures in the hematite ironstones is also unstable and is dissolved during the diagenesis. Specularite or magnetite grows instead, although not necessarily at the place that contained the hematite pigment. Intraclasts, oolites and pisolites are therefore commonly replaced by specularite or magnetite patches; some of these patches may still show traces of the concentric textures of former oolites and pisolites. Iron is thereby enriched in certain layers or in irregularly outlined patches that are commonly aligned parallel to the bedding; these patches that are enriched in specularite and magnetite constitute the "metallic" veins. Iron has been partially or totally leached from other patches. Siderite concretions formed quite commonly in the hematite ironstone and fairly regularly replaced the cores of pisolites and less commonly of oolites. Finally veins filled with specularite, magnetite, quartz, or siderite cut the ironstone and further obscure the original structures and textures.

The different varieties of jasper described in the stratigraphical section are in part characterized by typical sediment textures. Thin bedded jasper is essentially matrix chert. Intraclastic and oolitic rocks predominate in the thick bedded jasper where they commonly alternate with beds of pelletoidal matrix chert showing coarse laminations on a cm scale. "Grey cherty metallic iron formation" is mainly composed of intraclastic, and oolitic rocks that are heavily recrystallized. The brick red jasper beds of the "jasper metallic iron formation" are commonly pelletoidal matrix chert, whereas the grey interbeds contain intraclasts and/or oolites. Cherty varieties are, on the whole, much more recrystallized than are the silicate-carbonate ironstones, and intraclastic and oolitic rocks appear to be particularly affected by the diagenetic recrystallization and metasomatism.

Origin and sedimentary environment

The characteristic sediment textures and structures of the Sokoman that are analoguous to, but not identical with, the textures and structures of limestones suggest possibles that the Sokoman has been deposited as a cherty ironstone, and that it is not produced by replacement of a calcareous rock by siliceous and iron bearing solutions. The iron and silica were apparently transported into the basin in solution or in colloidal suspension, and were precipitated in the basin.

There are two contrasting opinions on the origin of the iron and silica: Kirkland (1950) and Dufresne (1952) suggested that the iron and silica were probably derived from a land mass under conditions of intense chemical weathering. The main source is supposed to be in the east of the Labrador trough. Baragar (1967), on the other hand, proposed that the iron and silica might be derived from a volcanic source.

The writer can make no valid contribution to this problem. The Sokoman was apparently deposited under very stable tectonic conditions. That an adjoining land mass, if it existed, was subject to intense chemical weathering, is not unlikely. On the other hand, a thick pile of volcanic material underlies the Sokoman. Sills belonging to this pile show a differentiation trend towards extreme iron enrichment. It is quite possible that their extrusive equivalents show the same trend. The idea that the iron of the Sokoman Formation is derived from volcanic sources, is therefore perfectly credible. A systematic study of the chemical variation of the volcanic rocks in function of their stratigraphy might help to decide this case: It would certainly strengthen Baragar's argument, if it could be shown that the iron rich volcanic volcanic trend culminates shortly before or during Sokoman deposition.

The precipitation and sedimentation of the Sokoman has been discussed by Dimroth (1968) and Dimroth and Chauvel (1972, 1973). The silica carried into the sea water was apparently precipitated in form of very fine drops. Iron was precipitated as - possibly hydrous - iron silicate, as iron carbonate, or as iron hydroxide, depending on the acidity and oxidation potential of the sea water. The writer inferred from sediment textures that the iron silicate and iron carbonate were precipitated in the form of crystalline particles and were deposited as fine-grained muds. Ferric hydroxide, on the other hand, was probably adsorbed to silicagel drops. Occasionally silicagel drops would aggregate in the sea water to from pellets. These primary particles were deposited under relatively quiet water conditions as laminated silicate-carbonate ironstone (femicrite) as matrix chert and as pelletoidal matrix chert.

The rocks of the first generation were eroded by occasional strong currents within the basin. Intraclasts formed during their erosion; they were transported, generally for insignificant distances, and redeposited. Intraclasts of the silicate-carbonate ironstone are generally embedded in a matrix. Intraclasts of hematite ironstones, on the other hand, were deposited as clean "sand" and were cemented after their deposition. Both types of intraclastic rocks are therefore different. Oolites and pisolites formed in shallow water under strongly turbulent hydrodynamic conditions. Stromatolites were observed in hematite ironstones south of the area, (G.D. Jackson, oral comm. 1968) and onkolites probably of algal origin occur here and there in the area. Both indicate very shallow water, and presence of organic life during the deposition of the iron formation. Length-slow chalcedony is not uncommon; this variety of quartz grows under evaporitic conditions (Pittman and Folk, 1971).

The gradation of the member 1 of the Sokoman into the pelitic Ruth Formation to the northwest indicate that a continental source area extended farther west, although probably at great distance. Delicate tabular laminations are characteristic of the member 1 of the Sokoman and of the Ruth slate. Fine micro-crosslaminations occur in the Ruth siltstone. Both suggest deposition in relatively quiet water below wave base. High carbon contents in the Ruth, and precipitation of bivalent iron in the member 1 of the Sokoman prove deposition under reducing conditions. Sedimentation in a relatively shallow sea, below wave base, appears probable.

Zajac (1970) inferred that the Ruth slate south of Lac le Fer was derived from volcanic islands extending close to Astray Lake, south of the present area. The Ruth siltstone north of Helluva Lake, on the other hand, is certainly derived from a continental source extending farther west (Dimroth et al. 1970). Generally water depth increased toward the east, but on the whole the Ruth was probably deposited in a shallow sea with poor circulation, under essentially anaerobic conditions.

Precipitated iron silicates (lower silicate-carbonate ironstone) predominates at those localities where clastic supply was at a minumum, in particular in extreme east of the trough, and on top of internal ridges. One of those ridges extended north-northwest from Stakit Lake to Boundary Lake (Zajac 1970); thinly laminated jasper was deposited on top of this ridge. The other prominent ridge developed in the centre of the trough, east of Attikamagen Lake (Zajac 1970). Its presence is also indicated by clastic material that has its source farther east, along Ferrum River and at Hematite Lake (Chauvel and Dimroth, in print). The sea was very shallow during the deposition of members 2, 3, 4 and 5 of the Sokoman. On the whole a shallow marine basin extended between the east of Helluva Lake and Squaw Lake. It was bounded in the west by a lagoonal-littoral domain, and in the east by a zone of shallow submarine shoals. Southeast of Otelnuk Lake and west of Hematite Lake deposition was in a shallow to deep lagoonal environment. Some clastic components reached the western basin, at Hematite Lake from the east, and at Attikamagen and Squaw Lake perhaps from volcanic islands (described by Sauvé 1954) to the south.

Little is known about the sedimentary facies and paleogeography of the Sokoman in the zone between d'Oiseaux Lake and Low Lake. At d'Oiseaux Lake parts of the formation are coarsely intraclastic and were deposited in very shallow water, whereas the finely laminated lower silicate-carbonate ironstone is in a deep water facies. Length-slow chalcedony occurs, indicating evaporitic conditions (Pittman and Folk, 1971). North of Low Lake the formation is absent; either because it has been eroded before Menihek deposition, or because of non-deposition.

The Sokoman is also absent in the centre of the trough north of latitude 56^{o}N, where the Mistamisk Basalts overlie the Bacchus Lake Formation. Again the formation may have been eroded in this zone before Mistamisk deposition, or it has not been deposited. Sand, that occurs in the Sokoman near Hematite Lake, may be derived from that area.

MENIHEK FORMATION

The Menihek Formation has first been introduced by geologists of Labrador Mining and Exploration Company and was formalized by Harrison (1952). The name refers to a thick pelitic unit overlying the Sokoman Ironstone.

The lower contact of the Menihek appears to be generally abrupt and conformable. Alternation of cherty ironstones with slates in the contact zone has locally been described but appears to be an exceptional features. Ironstone conglomerates have been observed at the lower contact of the Menihek at a few other localities (Baragar 1968, Iron Ore Company of Canada, private reports). These have generally been interpreted as indicating disconformable contacts. However such interpretations must be regarded with caution.

Intraclastic conglomerates are not uncommon in ironstones, and do not indicate disconformable contacts. On the other hand, true ironstone conglomerates, containing ironstone fragments in a clastic matrix, exist in stratigraphic horizons (Chioak Formation) that correlate with the Menihek north of 57° (Bergeron 1959, Bérard 1965). An unconformity between the Sokoman and Menihek equivalents is well documented north of 57°, but its presence has not been demonstrated convincingly south of that latitude. Even north of 57° the unconformity is local, and concordant contacts are present at many places.

At Ritchie and Purdy Lakes dolomite overlies the Sokoman Ironstone, and shales overlie the dolomite. The dolomite was named Purdy Formation by Iron Ore Company of Canada and by Frarey and Duffell (1964), and the shales were correlated with the Menihek Formation (Iron Ore Company of Canada, private reports, Frarey and Duffell 1964, Baragar 1967) on the basis of poor outcrop. An unconformity was assumed at the base of the Purdy and Menihek.

Later the writer (Dimroth et al. 1970) followed the Alder and Uvé Formations from southwest of Otelnuk Lake into the so-called Purdy Formation. Correspondingly the term Purdy Formation has been dropped. The shale overlying the dolomite horizon has been proved to correlate with the Swampy Bay Subgroup. The Menihek Formation does not occur in the area southwest of Wakuach Lake.

Concordant contacts between the Attikamagen, Wishart and Sokoman have furthermore been observed at lat. 55°26', long. 67°41' northwest of Lac le Fer. This observation, which voids the previous correlation of the shale with the Menihek Formation is in agreement with field observations by geologists of Iron Ore Company of Canada (private reports).

In the present area the Menihek occurs in three zones:

1. It forms the highest exposed unit in the basal tegument of the foreland of the trough southwest of Otelnuk Lake.
2. It forms the highest exposed unit in a number of thrust slices of the imbricate zone between Helluva Lake and Schefferville, and in a synclinorium extending from Lac le Fer to Attikamagen Lake.
3. It underlies a zone in the eastern part of the trough between d'Argent Lake and Doublet Lake. In this area the formation is overlain by a pyroclastic sequence (Murdoch Formation) and has been intruded by numerous gabbro sills.

In zones 1 and 2 the Menihek is represented by black laminated shales, impure sandstones, and greywackes. A considerable proportion of flow basalt and of basaltic agglomerates occurs at the top of the formation in zone 3.

Stratigraphy and petrography

Southwest of Otelnuk Lake only part of the Menihek is well exposed at the rapids of Swampy Bay River, below the High Falls, and at the north shore of Veronot Lake. Only a few outcrops of the formation signal its presence farther south. At Swampy Bay River four sub-units were mapped; their sequence, in descending order, is as follows:

4)	gray laminated shale with some greenish grey quartzite	100 feet
3)	grey bedded and thickly bedded quartzite, minor laminated shale	100 feet
2)	as 4)	100 feet
1)	as 3)	>50 feet

This section is relatively high in the Menihek, and represents only small part of the formation. Outcrops farther south and north expose similar lithologies.

The shales are laminated on a mm-cm scale, and consist of alternating layers of grey, slightly graphitic shale and siltstone. The quartzites are very fine-grained they occur in beds 10-300 cm thick. Laminations are generally not visible in outcrop but were observed in thin section. Cross-lamination is common. The quartzite consist of 60-70 per cent quartz and minor albitic plagioclase set in a matrix of sericite and chlorite. Grain sizes are between 0.05 and 0.2 mm. Dolomitic concretions are quite common at Veronot Lake.

The writer observed only a few outcrops of the Menihek in the zone between Lac le Fer and Attikamagen Lake; all of them are at the base of the Formation. The following description is therefore in part abstracted from Baragar (1967).

The part of the Menihek directly overlying the Sokoman is composed of a silt-laminated black, graphitic slate. Laminations are on a cm and mm scale. Graphitic slate predominates at the base of the formation, whereas the proportion of silty material apparently increases upwards.

Higher up in the sequence Baragar described alternation of greywackes and shales. The greywackes, according to Baragar, are generally fine-grained, dark grey rocks, composed of quartz, feldspar, and chloritic patches derived from volcanic material set in a chlorite-sericite matrix. Iron Ore Company of Canada (1952) describe shale pebbles in the Menihek at Petitsikapau Lake, south of the present area. Spherical dolomitic concretions have been observed in the Menihek at a number of localities (Iron Ore Company, private reports).

The formation is closely folded in the synclinorium, and it is therefore impossible to determine its thickness. The thickness preserved in thrust slices of the western zone does not exceed 600 feet; total thickness of the preserved portion in the main synclinorium is certainly above 2000 or 3000 feet.

Only few outcrops of the Menihek in the eastern zone were visited by the writer. The reader is referred to Baragar (1967) for more adequate description in this area. On the whole it appears that the Menihek in this zone can be subdivided in two stratigraphic members. A lower unit, composed of shales, and siltstone with minor greywacke overlies the Sokoman, and can be traced from d'Oiseaux Lake nearly to Low Lake. An upper unit alternates with gabbro sills, and is composed of graphitic slate, of laminated siltstone, pyritic slate and massive pyrite, basalt, and pyroclastic rocks.

Grey massive silty slates with dolomitic concretions appear to be particularly characteristic of the lower unit. Silt-laminated graphitic slates similar to those described above occur in the whole of the formation. Laminated pyritic slates composed of alternating laminae, 1-10 mm thick, containing more and less pyrite, and massive pyrite beds occur only in the upper unit. The pyritiferous beds can locally be traced for several miles. They are closely associated with basaltic rocks and gabbros.

Several beds of agglomerates, 10-200 feet thick, occur in the upper part of the formation. They are composed of basaltic and gabbroic fragments of up to 1 foot diameter, set in a sheared basaltic matrix composed of chlorite, actinolite, albite, calcite and sphene. Fragments of dolomite and of shale were observed at some localities.

Basalts occur at least at two stratigraphic horizons: they are relatively widespread at the top of the formation, whereas basalts associated with agglomerates occur southwest of Jean Lake in the middle of the formation. The lower basalt unit is up to 500 feet thick, whereas the upper unit attains a largest thickness of 2000 feet. Both lens out very rapidly along strike. Glomeroporphyritic basalts containing feldspar aggregates 5-20 mm across are not uncommon in the upper basalt unit northeast of lac Aubin. The basalts flows are between 5 and 20 metres thick; massive basalts, pillowed basalts, and hyaloclastic basalt breccias are closely associated. The basaltic rocks are described in detail in pages 128-132.

It is likely that some of the gabbroic sheets intercalated between the Menihek are also of extrusive origin. Gradation of a gabbroic sheet into clearly extrusive basaltic rocks appears occurs east of Lac Aubin although the relations are not as well documented, and have not been as well studied, as in the Bacchus Lake Formation (pages 128-132).

Folding and poor outcrop do not permit to establish the precise thickness of the Menihek in the eastern zone. The lower part of the formation certainly exceeds 2000 feet at the latitude of d'Oiseaux Lake. The shales between the gabbro sheets may be 1000 to 2000 feet thick west of Bacchus Lake. The lower basalt unit east of Bacchus Lake is about 500 feet thick and the basalt unit at the top of the formation attains its greatest thickness of ca 2000 feet east of Lac Aubin. About 4000 metres (12000 feet) of gabbro sheets are intercalated.

Depositional environment

The facies of the Menihek Formation indicates deposition in a relatively deep basin under unstable tectonic conditions. Volcanic eruptions took place in the east of the basin. Internal uplifts probably existed during the early part of Menihek deposition. Their presence is inferred from the thickness relations of Menihek equivalents north of 57°, from the apparently disconformable contact of the Mistamisk Formation with the underlying rocks north of 56°15', and from the reported presence of conglomerates in the Menihek at Petitsikapau Lake (Private reports of Iron Ore Company of Canada). Volcanic activity is restricted to the upper Menihek. Although this evidence is of a somewhat tenous nature, it appears to indicate that Menihek deposition occurred under conditions comparable to the deposition of the Attikamagen Subgroup.

MISTAMISK FORMATION

A basaltic unit underlies large areas northeast and southwest of Mistamisk Lake and extends at least for 60 miles to the north into the regions mapped by Roscoe (1957), Fahrig (1956b), and Hashimoto (1964). This unit is here named Mistamisk Formation. The type section is southeast of Mistamisk Lake between lat. 56°29', long. 68°15' and lat. 56°24', long. 68°17'.

The Mistamisk Formation overlies the Bacchus Lake Formation, and is composed of the same lithologies. Consequently its lower boundary has to be established by definition.

In the type section the Mistamisk Formation is subdivided in three units, listed here in descending order:

(3) More than 5000 feet of massive and pillowed basalt flows, with 2 or 3 intercalated gabbroic sheets and thin interbeds of graphitic shale, siltstone, and impure sandstone.

(2) About 100 feet of laminated shale and siltstone with three intercalated gabbroic sheets of about 1000 feet aggregate thickness.

(1) Approximately 500 feet of pillowed basalt with a little intercalated sedimentary material as in unit 1.

The top of the formation is not exposed in the present area. Farther north however the formation grades into overlying pyroclastic rocks with local acidic phases.

The lithologies of the Mistamisk Formation correspond closely to those of the Bacchus Lake and the reader is referred to the descriptions at pages 128 to 132.

The stratigraphic relations of the Mistamisk Formation have not been established to the writer's complete satisfaction. There is however, reasonable evidence, admittedly of a somewhat tenous nature, to assume that the Mistamisk Formation corresponds to the higher part of the Menihek Formation. The reasons for this correlation will be outlined in some detail.

South of 56° latitude, the Bacchus Lake Formation is overlain by the Denault Formation and by rocks of the Ferriman Subgroup. These units are successively missing at about 56°N latitude east of Effiat Lake: At Low Lake (lat. 56°53', long. 67°05') the Denault, Wishart and the lower member of the Sokoman are still present, whereas the upper member of the Sokoman is lacking. At lac d'Argent (lat. 56°00', long. 67°07') the Wishart and Sokoman are absent, and only the Denault remains. North of Lac Curaillon finally the last outcrops of the Denault occur. In this area the Denault is overlain by slates of the Menihek and by a very thick sequence of greenschists that has here been mapped as Murdock Formation, but that comprises at least 50 per cent of metamorphosed pillow basalts as they are more characteristic of the upper Menihek Formation farther south and of the Mistamisk Formation farther northwest. The observations discussed in this paragraph appear to suggest that the Denault, Wishart and Sokoman Formations are absent in the east of the trough north of 56° lat., and that the overlying suite is largely composed of pillow basalt.

North of latitude 56° the typical sequence of the Bacchus Lake Formation has been mapped in the Otelnuk, Mistamisk, and Dunphy Lake areas. It is overlain by the basalts of the Mistamisk Foramtion. The Bacchus Lake Formation lenses out north of 56°30'. Therefore no doubt exists that the Mistamisk Formation overlies the Bacchus Formation.

The volcanic rocks of the Mistamisk Formation have been mapped north of 56°30' lat. by Roscoe (1957), Fahrig (1956b), Hashimoto (1964), and Dressler (1972). At Wapaniskan Lake they overlie the Archaean basement gneisses, the Wishart and Sokoman Formations and shales overlying the Sokoman (Menihek equivalents). The lower contact of the Mistamisk in the Wapaniskan area can be interpreted either as an unconformity or as a thrust fault. There is no evidence of thrust faulting at that locality (Hashimoto 1964). Furthermore the Mistamisk is overlain by pyroclastic rocks that comprise acidic phases. Similar to the rocks of the Murdock Formation. Therefore the writer (Dimroth 1970, Dimroth et al. 1970) assumed an unconformity rather than thrust faulting at the lower contact of the Mistamisk at Wapaniskan Lake.

The evidence discussed in the preceding paragraphs suggests that the Mistamisk Formation corresponds to the volcanic rocks in the upper Menihek Formation and possibly to parts of the Murdock Formation. It is consequently inferred that the Denault Formation, as well as the Ferriman Subgroup are absent in the centre and east of the trough north of 56°. Whether these formations were not deposited, or whether they were eroded before the deposition of Mistamisk Formation is unknown. However there are some indications suggesting that the formations were not deposited in the area underlain by the Mistamisk Formation: (1) The western Labrador trough north of 55°30' was apparently emerged during the time of Denault deposition (Dimroth 1971). (2) The lower Sokoman Formation east of Hematite Lake contains clastic material that is suspected to be derived from an easterly source. Obviously the area around Mistamisk Lake is a possible source of the clastic material.

SUBORDINATE VOLCANIC ROCKS IN THE KNOB LAKE GROUP

Subordinate volcanic rocks occur in the Chakonipau, Dunphy, Lace Lake, Wishart, and Ruth Formations. The volcanic bodies are small. Four associations are present:

1. Basalt flows and tuffs, described at page 42 occur in the Chakonipau Formation at Lac Musset (Baragar, 1967).
2. Acidic lava east of Otelnuk lake at lat. 56°10' long. 68°10' is probably in the Chakonipau Formation.
3. Chlorite schists and biotite schists occur in the Chakonipau, Dunphy and Lace Lake Formations in the Romanet-Mistamisk Lake valley.
4. Tuffs and tuffitic sandstones occur in the Wishart and Ruth Formations in the south of the area (Iron Ore Company of Canada, private maps; Sauvé, 1954; Gross, 1968; Zajac, 1970).

Only those rocks were included here which certainly are extrusive. Some other basic or intermediate rocks, which might be of extrusive origin, have been included with the Montagnais Group (pp. 218-245).

The basaltic rocks in the Chakonipau Formation at Musset Lake have been described in page 42. A small cliff of a red, cherty acidic volcanic is exposed east of Otelnuk lake. The rock shows flow lamination. The rock is extremely fine-grained, and probably is derived from a volcanic glass; minerals cannot be identified with the microscope. Pegmatitic veins follow joints and are mineralized with chalcopyrite and pyrite.

10' thick beds of green chlorite schists are present in rocks of the Chakonipau and Dunphy Formations at a few localities west of Romanet lake. The rocks are bright green, extremely fine-grained and somewhat schistose. They are composed mainly of chlorite, albite, sericite and calcite. Irregular patches of calcite, probably original amygdules, are common.

Dark biotite-muscovite-albite schists and various types of chloritic schists are exposed here and there along Romanet river and are derived from extrusive or intrusive rocks. They are described with the Montagnais Group under the heading "extrusive and intrusive rocks of doubtful origin".

Beds, several inches to several feet thick of tuffs and of tuffitic sandstone and shale occur in the Wishart and Ruth Formation southwest and east of Schefferville. They have been described in unpublished reports of Iron Ore Company of Canada, by Gross (1968) and Zajac (1970). The tuffs are probably derived from volcanic islands that extended at that time in the Astray Lake area (Sauvé 1954).

The tuffs are dark olive green rocks composed of rounded volcanic fragments set in a chloritic matrix. Their grain size varies from less than a mm to about 1 cm. Volcanic fragments contain abundant alkali feldspar, in form of slender lath-shaped crystals set in a largely chloritized groundmass. Pyrite commonly replaced part of the matrix and of the fragments.

DOUBLET GROUP

The name Doublet Group has been introduced in 1952 by Harrison (1952). Later the Murdock Group, also introduced by Harrison (1952) was relegated to formational status and included with the Doublet (Frarey and Duffell 1964). The name refers to the predominantly mafic volcanic units overlying the Menihek Formation in the eastern Labrador trough, south of 56° latitude. The Doublet Group is subdivided as follows:

3. Willbob Formation: mainly basalt
2. Thompson Lake Formation: slate, quartzite, conglomerate, iron formation, basalt
1. Murdock Formation: mainly mafic pyroclastic rocks.

The writer has done little work in the Doublet Group and the following descriptions are in part briefed from Baragar (1967) and Frarey (1967). The reader is referred to both authors for more detailed information.

MURDOCK FORMATION

The name Murdock Formation refers to a band of predominantly pyroclastic rocks in the east of the trough, typically exposed north and east of Murdock Lake. The name was first introduced as Murdock Series (Labrador Mining and Exploration Co., private reports), then used as a rock stratigraphic term (Murdock Group, Harrison 1952) and later relegated to formational rank and included with the Doublet Group (Frarey and Duffell 1964).

The lower contact of the Murdock Formation is not exposed in the present area. Frarey (1967) mapped it as a fault intersecting the stratigraphic horizons of the upper Menihek in the area west of Doublet Lake, and the same relations exist in the area east of Bacchus Lake mapped by the writer. The fault zone, composed of at least two en echelon faults continues certainly along the west shore of Murdock Lake as far as lat. 55 35'. Farther north however, Baragar (1967) noted little evidence of faulting: outcrops of Murdock pyroclastics and of basalts of the upper Menihek occur separated only by few feet of drift northwest of Murdock Lake, and Baragar assumed that the contact was essentially conformable. An unfaulted contact between Menihek basalts and the Murdock is also present southeast of Lac Aubin. North of $55^{\circ}45'$ the relations at the western contact of the Murdock are obscured by poor outcrop. It is likely a fault line between lat. $55^{\circ}50'$ and lac d'Argent. North of lac d'Argent the Murdock Formation overlies shales of the Menihek, and there is again little evidence of faulting.

The relations at the western contact of the Murdock are therefore by no means clear; it is certain that some faulting occurred along most of its strike length, but there are least two localities were there is good reason to believe that movement was minimal. There is no abrupt lithological break at the contact between the Menihek and Murdock Formation: The top of the Menihek contains lenses of flow basalt, and some pyroclastic material. The Murdock is essentially composed of pyroclastic rocks, but flow basalt, and shales are by no means absent, particularly at the base of the formation. The writer agrees with Baragar's (1967) opinion that the widespread faulting at the western contact of the Murdock may be explained by telescoping of a gradational zone induced by the strong mechanical contrast between the massive and competent basalt-gabbro association west of the fault, and the soft and incompetent pyroclastic sequence to its east.

The Murdock Formation is composed of relatively thin stratigraphic units, with predominating pyroclastic material (breccia tuffs, lapilli tuffs, ash tuffs of mainly basaltic composition, minor acidic tuffs) subordinate basalt flows, and sediments (graphitic shale, quartzite, greywacke, pyritic shale and massive pyrite). Its composition is abnormal in the area north of 56° lat., where pillow basalt compose at least 50 per cent of the formation. Poor outcrop does not permit to follow individual stratigraphic units. On the basis of aeromagnetic maps (Labrador Mining and Exploration Company, unpublished and of limited field work the writer implies that the individual volcano-stratigraphic units have little lateral continuity, and lens out on the average after a few thousand feet. It appears likely that the formation is composed of a multitude of interdigitating volcanic units erupted from cones or from short linear fissures.

North of 56°N latitude the formation is in large part composed of pillow basalt, alternating with minor breccia and ash tuffs and with much lapilli tuff. At Murdock Lake the lower ½ of the formation is composed of breccia and lapilli tuff with considerable flow basalt, and minor ash tuff, all of basaltic composition. The upper ½ of the formation consists mainly of lapilli tuff with minor ash tuff and breccia tuff. Acidic tuffs, as well as more massive rocks with acidic pods occur. These volcanic rocks are interspersed with maybe 10 per cent of sedimentary material, comprising graphitic slate, chert or cherty slate, quartzite, greywacke, laminated pyritic slates and massive pyrite beds.

The breccia tuffs contain subangular fragments up to 20 cm across mainly of gabbroic and basaltic material in a strongly sheared chlorite schist matrix. They do not show bedding. Lapilli tuffs contain poorly outlined basalt fragments in a chloritic matrix; they are poorly bedded on a scale of 5-20 cm. Ash tuffs are well laminated on a mm-cm scale.

All the rocks of the Murdock Formation are metamorphosed to the biotite-albite-epidote-quartz subfacies of the greenschist facies; north of 56° parts of the Murdock Formation are in the almandine-biotite-albite-epidote-quartz subfacies. Rocks are generally sheared. The fragments have been deformed and are now composed of a mesh of actinolite, albite, epidote, minor sphene and magnetite. The sheared matrix generally forms a more or less well oriented fabrics of the same minerals with much chlorite. In strongly sheared rocks a segregation of mafic minerals and albite in laminae a few mm across parallel to the schistosity develops, and may easily be confounded with bedding. Many of the rocks are so strongly deformed that their original derivation is obscured.

A conglomerate has been observed at the base of the formation at Walsh Lake (Frarey 1967); similar conglomerates have also been described south of the present area (Labrador Mining and Exploration Company, private reports). The conglomerate is composed of pebbles of quartzite, argillite, grey chert, jasper, and a few dioritic and felsitic fragments in a quartzitic matrix.

It is impossible to give more than very approximate estimates of the thickness of the Murdock Formation. North of 56° the formation may exceed 3000 or 4000 feet. Northeast of Low Lake it is tectonically reduced to probably less than 1000 feet. Its thickness at Doublet Lake has been estimated to be between 2000 and 5000 feet (Frarey 1967).

THOMPSON LAKE FORMATION

The name Thompson Lake Formation has been introduced by Frarey and Duffell (1964) for a predominantly sedimentary sequence overlying the Murdock Formation. Numerous sills of gabbro and of serpentinized peridotite are intercalated with the other rocks of the unit; some of these might be thick flows and would belong to the sequence.

The thickness of the sedimentary and clearly extrusive rocks of the Thompson Lake Formation varies from about 300 feet north of 56° to about 2000 feet at Doublet Lake (lat. 55°15', Frarey 1967). Intercalated gabbros and peridotites attain a cumulate thickness of about 2000 feet north of 56° and of approximately 3000-5000 feet east of Ahr Lake and farther south.

The lower contact is not exposed. Mapping, particularly in the Thompson Lake, and Ahr Lake area, as well as north of 56° leaves no doubt that the unit overlies the Murdock Formation. Locally the contact between both units may interfinger.

Dominant lithologies in the Thompson Lake are silt-laminated shales, quartzites, and conglomerates. Volcanic units, mainly pillowed basalt, have been mapped in the Formation by Frarey (1967). Pyritiferous shales and massive pyrite bodies are not uncommon, and command considerable economic interest.

The quartzitic rocks in the Thompson Lake Formation are generally medium-bedded. Cross-lamination is common. The rocks have a characteristic open fabric of mm-sized quartz grains set in a matrix. Orthoquartzites having a recrystallized quartz matrix and greywackes with a pelitic matrix and containing shale fragments have been observed. Conglomerates contain cm-sized fragments of quartz, and felsite.

The shales are silt-laminated on a cm-mm scale. Cross-lamination and flaser-laminations are common. All gradations exist between fine-grained quartzites with a few pelitic laminae and pelites with thin silty laminae. Important local varieties are (a) graphitic shales, very soft, easily weathering rocks with very fine laminations containing much graphite and some pyrite; (b) pyrite laminated shales, with laminae 1-10 mm thick containing much pyrite and (c) massive pyrite beds. The latter three varieties are poorly exposed, but can be traced through gossan zones for distances that attain more than two miles.

The sediments are generally metamorphosed to the biotite-albite-epidote subfacies of the greenschist facies. North of 56° their metamorphism attains the grade of the almandine-biotite-albite-epidote subfacies. Their sedimentary structures however are remarkably well preserved for rocks of this metamorphic grade, and metamorphic minerals are commonly quite fine-grained.

North of 56° the formation comprises metamorphosed tuffs and pillow basalts that have been converted to hornblende schists and to hornblende-garnet schists. The hornblende schists contain unoriented hornblende prisms, up to 4 cm long, set in a fine-grained matrix composed of plagioclase, epidote, and hornblende. Garnet schists contain round garnet porphyroblasts, up to 3 cm across, and hornblende prisms up to four cm long, set in a similar matrix. Both rock types show well preserved relict bedding.

Ironstones occur in the Thompson Lake Formation northeast of Murdock Lake. The ironstone forms a lenticular body with silicate-carbonate ironstone enveloping a core of hematite ironstone. Hematite ironstone is laminated on a mm-cm scale. It is composed of granular quartz, specularite, magnetite, and minor stilpnomelane and iron amphibole. Silicate-carbonate ironstone is composed of alternating beds, 1 to 10 cm thick, rich in quartz and rich in iron carbonate. It is mainly composed of quartz, iron carbonate, stilpnomelane and iron amphibole. Baragar (1967) described the occurrence in considerable detail.

Volcanic units occur here and there in the Thompson Lake Formation. They are most conspicuous at Thompson Lake (Frarey 1967), where they exceed 500 feet. The flows are generally well pillowed and resemble the metabasalts of other formations (descriptions see p. ~~103a-103d~~ 128 - 132). Some of the gabbroic sheets shown as belonging to the Montagnais Group may also be extrusive and may form an integrating part of the formation. A peculiar type of agglomerate was observed west of lac Marbrelle. The rock consists of strongly deformed fragments of a felsitic volcanic. The fragments are composed of plagioclase laths, biotite, some quartz and magnetite. They are set in a matrix of similar composition but of larger grain size.

WILLBOB FORMATION

The Willbob Formation, also defined by Frarey and Duffell (1964), comprises the upper, volcanic, unit of the Doublet. It extends from north of latitude 56° southeastward to André Lake at lat. 54°30'. It is the highest formation occurring in this segment of the trough; its top and total thickness are consequently unknown. The present thickness exceeds 3000 feet at latitude 56°N. and 15000 feet at latitude 55°15' (Frarey 1967).

The formation consists predominantly of pillowed and massive basalt flows with minor interbands of tuff and thin, lenticular interbeds of argillite, shale and pyritic shale. Lenses of relatively coarse-grained gabbroic rocks occur. They have been mapped as gabbro, and have been included with the Montagnais Group, although some of them might represent extrusive material.

Pillowed flows of metabasalt, as described with the Bacchus Lake formation predominate. The flows weather light grey, green or buff, and are pale grey to black on the fresh surface. The great variation in colour suggest that chemical variations exceed those of the basalts in the Bacchus Lake Formation. Some of the flows contain glomeroporphyritic feldspar aggregates up to several cm across.

Pyroclastic beds were not observed by the writer, but have been described by Frarey (1967). They are generally lenticular, lensing out within a few hundred feet; their thickness commonly does not exceed 50 feet. One band, 500 feet thick has been followed for several miles by Frarey (1967).

Thin lenticular bodies of graphitic shale, pyritiferous shale and massive pyrite occur at numerous localities in the Willbob Formation. Thicker bands of shale and greywacke occur east of Ahr Lake and have a tendency to be intruded by gabbro and serpentinite sills.

LAPORTE GROUP

The name Laporte Series was given by geologists of Labrador Mining and Exploration Company to metamorphic schists, gneisses and amphibolites at Laporte Lake (lat. 55°05', long. 65°45'). Harrison (1952) formalized the name as a rock stratigraphic term (Laporte Group). From Laporte Lake the schists extend in a continuous zone east of the Labrador trough.

The rocks of the Laporte Group are in fault contact with the Doublet Group in the type area and in the Wakuach Lake area (Baragar 1967). Their stratigraphic position was therefore unknown; however Fahrig (1951) and Baragar (1967) recognized that the Laporte Group correlated with Kaniapiskau strata. The Elsie Lake fault that bounds the Laporte Group in the Wakuach Lake area terminates at 56° and unfaulted contacts exist north of that latitude. The stratigraphic position of the Laporte rocks can therefore be recognized in the northern part of the present area.

North of 56° the Laporte Group occurs in synclinal zones east of the Labrador trough proper, mantling domes of the remetamorphosed Archaean Wheeler Complex. The Wheeler dome centered at 56°15', 67°20', is mantled by the sequence comprising the Seward, Pistolet, and Swampy Bay Subgroups, the Denault and Menihek Formations and the Doublet Group in the west. Many of these stratigraphic units wedge out already on the western limb of the dome. Some units can be traced to the south of the dome, and occur at lat. 56°05'. long. 67°07'. At that locality the sequence overlying the basement comprises: (1) meta-arkoses and meta-conglomerates equivalent to the Milamar Formation; (2) meta-pelites with interbedded metamorphosed dolomitic sandstone and sandstone correlating with the Lace Lake Formation; (3) metagabbros that correspond to the gabbros in the Bacchus Formation; there is also some metapelitic sediment between the metagabbros; (4) metamorphosed pyroclastic rocks and pillow basalts of the

Murdock Formation. The sequence is poorly exposed and there may be considerably more sedimentary material in unit (3) than shown on the map. The same sequence occurs in the east of Wheeler dome at lac Elephant.

Farther north and northeast, at Duhamel Lake, the basal arkose unit (1) and the gabbroic rocks (3) lens out, whereas the proportion of pelitic rocks with interlayered sandstone beds increases. East of Duhamel Lake the lower part of the sequence is still very similar to the Lace Lake Formation, comprising beds of dolomitic sandstone, dolomite, and quartzite. The upper part of the sequence appears to consist essentially of graphitic pelites and impure sandstones and probably corresponds essentially to the Bacchus Lake and Menihek Formations. Both contain some metamorphosed volcanic material, now represented by amphibolites, and some metagabbroic sheets.

Toward the northeast the differences between the lower and upper sequences disappear; the gneiss zone in the northeast of the Wheeler River map-area is mantled by a sequence of predominantly biotite-plagioclase gneisses derived from semipelites and impure sandstones, with thin but characteristic intercalations of the following rock types: (1) metaquartzite, rare meta-arkose; (2) metamorphosed dolomitic sandstone (calc-silicate quartzite) and metamorphosed marls (calc-silicate amphibolite); (3) aluminous pelites (kyanite and sillimanite gneiss); (4) meta-volcanic rocks (amphibolites) and (5) ultramafic rocks (tremolite-olivine schists).

In the present area the Laporte Group therefore is essentially an equivalent of strata below the Murdock Formation, in a facies that makes subdivision into formations impossible except on a very detailed scale. This does of course not exclude that the Group also includes younger strata in other areas. The facies of the Laporte Group is characteristically different from the facies of the Labrador trough in so far as it comprises in close alternation a "matrix" derived from semipelites and impure arenites, with thin intercalations of mature sediments (quartzites, marbles, marls, etc.). This appears to be a characteristic of the facies of the immediate hinterland of the Labrador trough. There is some evidence that mature sediments further increase in quantity to the east (Taylor 1969).

In the present area the Laporte Group has been subdivided into four lithological units: (a) biotite schist, (b) biotite-plagioclase gneiss, (c) amphibolite and (d) tremolite schist.

The biotite schist is commonly well bedded on a cm-dm scale. It is composed of quartz, biotite, muscovite, and minor garnet. Grain sizes are generally between 0.1 and several mm, with exception of garnet that locally forms porphyroblasts up to 4 cm across. The texture is lepidoblastic. Interlayers of very fine-grained graphitic schist are common east of Duhamel Lake. A bed of pyrrhotite, with a peculiar pea texture has also been observed and may be of economic interest.

The biotite schist contains interbeds of quartzite, and of dolomitic sandstone. Quartzites are composed of a medium-grained quartz fabric with minor biotite and muscovite. Dolomitic sandstones often show still well preserved bedding on a cm scale, and occasionally show relictic clastic textures. They are composed of quartz, calcite, actinolite with minor biotite and muscovite. Dolomite beds and lenses have been converted to tremolite marbles, and beds of marl to tremolite-quartz-plagioclase schists.

The biotite-plagioclase gneisses are light grey rocks, composed of 30-50 per cent quartz, 30-60 per cent oligoclase, 5-30 per cent biotite and 5-20 per cent muscovite. Their grain size varies between 0.5 and 5 mm. Textures are granoblastic. Relictic bedding is commonly present on a cm scale. Interbeds, 5-20 cm thick, of white metamorphosed quartzite are common. At many localities interbeds of para-amphibolite have been observed. The beds of para-amphibolite are between 10 and 200 cm thick. They are composed essentially of a nematoblastic aggregate of actinolitic hornblende. Interbeds of aluminous gneisses contain prismatic crystals, up to 2 cm long, of kyanite and fibrous crystals of sillimanite besides biotite and muscovite. Some varieties also contain garnet. At one locality a 30 cm bed of a white, crystalline marble has been observed. Intercalations of white massive quartzite may attain about 10 metres.

The amphibolites are composed of hornblende, plagioclase, minor quartz, apatite, sphene, and magnetite. They generally have nematoblastic textures; relict ophitic textures are rare. The grain size of the amphibolites varies greatly and depends on the thickness of the amphibolite bodies. Generally the margins of the amphibolites have grain sizes between 0.1 and 0.5 mm, whereas the cores of thicker sheets may attain 1 cm largest size. The amphibolites are generally somewhat schistose. The rocks are derived from gabbros.

Ultramafic tremolite schists are light green medium- to coarse-grained massive or foliated rocks composed of olivine, a colourless tremolitic hornblende and antigorite, with accessory spinell and magnetite. They are derived from serpentinites. Similar tremolite schists have been described by Baragar in the Wakuach Lake area.

MONTAGNAIS GROUP

Frarey and Duffell (1964) and Baragar (1967) combined all gabbroic and ultramafic rocks of the area in the Montagnais Group. This grouping was logical as long as all coarse-grained mafic and ultramafic rocks were assumed to be intrusive, and were assumed to have intruded after the deposition of the rocks described above.

The writer has presented evidence (p. 131-132, and Dimroth 1971a) that some, and probably most of the gabbroic sheets are extrusive rocks, and crystallized from very thick basalt flows. These form an integrated part of the formations in which they occur (Bacchus Lake Formation, Menihek and Mistamisk Formations, Thompson Lake Formations). Other gabbro sheets have discordant contacts with their country rock and are clearly intrusive. These sheets are so closely related both in petrography and in composition to the extrusive basalts, that both have to be regarded as a cogenetic extrusive intrusive complex.

Ideally therefore one would wish to include those gabbroic rocks that represent extrusive flows with the formation in which they occur. Furthermore one would wish to group the intrusive gabbro sheets with their extrusive equivalents. Unfortunately this is quite impossible. It is not possible to prove the extrusive nature of more than a few sheets conclusively; on the other hand the chemistry, and the petrography of the gabbroic rocks is so uniform that a separation of different suites is quite out of the question.

For these reasons the term Montagnais Group is a convenient catch-all, into which all gabbroic and ultramafic rocks are grouped here, regardless of their age or origin. It is stressed that it is not a stratigraphic unit in the proper sense. Geological criteria suggest that many, and perhaps most, of the gabbro sheets in the Bacchus Lake

Formation are extrusive, and constitute an integral part of the formation. Some of the gabbro sheets at the top of the Menihek Formation, and some of the sheets in the Thompson Lake Formation are probably also extrusive. Gabbros that are set in the rocks of the Seward and Pistolet Subgroups have clearly intrusive contacts, and the same is true for most of the sheets in the Menihek Formation. The reader should note that the two main units of clearly intrusive gabbro (in the Seward Subgroup and in the Menihek Formation) underlie basalt sequences. Therefore it appears likely that the intrusive gabbro sheets in the Seward Subgroup are related to the extrusive basalts of the Bacchus Lake Formation, and that the gabbroic rocks intrusive into the Menihek Formation have their extrusive equivalents in the uppermost Menihek and in the Doublet Group. This hypothesis is to some degree substantiated by the fact that glomeroporphyritic gabbros (blotchy gabbros) occur only in the Menihek Formation; consequently their extrusive equivalents, glomeroporphyritic basalts, are present in the uppermost part of the Menihek Formation and in the Willbob Formation, but are absent from the Bacchus Lake Formation.

Two gabbroic associations are unrelated to extrusive rocks: A complex of gabbroic sills and stocks at Minowean Lake, and a series of gabbro sills at Hematite Lake. Both associations are set into the miogeosyncline. They form stocks, or relatively short sills, that do not have the great lateral continuity of the sill complexes that occur east of

Otelnuk and Wakuach Lakes. The sills at Hematite Lake intruded during the orogeny; their petrography and chemistry are also distinct.

In earlier literature the gabbros and peridotites were given formational names; the gabbros were named "Wakuach Sills" and the peridotites "Retty Sills" (Frarey and Duffell 1964). However the stratigraphic significance of the term "Wakuach Sills" is doubtful. As stated above the writer believes that the gabbroic sheets intruded and extruded during repeated periods of the evolution of the Labrador trough, and this voids the names of any stratigraphic significance. The peridotite sills on the other hand, occur only in a limited zone of the east of the trough, are closely associated, and it is not unreasonable to assume that they intruded during a relatively short period of time. The names will not be used in the following pages.

GABBROIC SHEETS

Gabbroic sheets underlie large zones of the central and eastern Labrador trough, and small, local gabbro sheets were even observed at a few places in the western Labrador trough, west of Hematite Lake and northwest of Wakuach Lake. In the present area we can distinguish five types of gabbros that are essentially characterized by their petrography, differentiation and petrochemistry. They are:

1. Normal tholeiitic gabbros
2. Tholeiitic gabbros with quartz-dioritic or oligoclasitic differentiates
3. Glomeroporphyritic gabbros
4. Spilitic gabbros
5. Trachydoleritic gabbros

Normal tholeiitic gabbros are the most abundant type, and constitute probably 80 per cent of all the sills. They are up to 2000 feet thick. They are differentiated sills. Tholeiitic gabbros with quartz-dioritic or oligoclasitic differentiates are probably a local variety of the normal tholeiitic type; in contrast to the latter type they contain sheets of the acid differentiates at the top instead of the pockets of gabbro pegmatites that occur in the normal sills.

Glomeroporphyritic gabbros are a variety containing rounded feldspar aggregates 1-15 cm across in a gabbroic matrix. They are closely associated with normal gabbro. Spilitic gabbros are essentially similar to the normal type but have a considerably higher soda/lime ratio due to soda-metasomatism after consolidation. The trachydolerite occurs only west of Hematite Lake and is characterized by high soda and potash contents in the rock, and primary crystallization of acid, potash-rich plagioclase.

Most of the gabbroic rocks in the centre of the trough south of 56° are little metamorphosed and contain essentially primary minerals. Gabbros in the east of the trough south of 56^{o} and those in the centre north of 56^{o} have been converted to epidote-amphibolites. Generally the original textures have been preserved, except in more highly metamorphosed areas. The gabbros in the northeast of the present area have been metamorphosed in the epidote-amphibolite and finally in the almandine-amphibolite facies.

Normal gabbros

Normal gabbros form sheets that are between 30 and 2000 feet thick. Sheets between 100 and 300 feet thick are most common. Some of the gabbroic sheets grade laterally into basaltic rocks as shown in pages 131-132. These are clearly of extrusive origin. Other sheets, particularly those in the Seward and Pistolet Subgroups cut across stratigraphic horizons and are certainly of intrusive origin. The sheets in the Bacchus Lake, Menihek and Thompson Lake Formations have generally concordant contacts and may comprise units that are extrusive and units that are intrusive. Baragar (1960, 1967) presented a detailed account on the petrography and petrochemistry of the normal gabbro sheets.

Contact metamorphic effects at gabbroic sheets are generally quite small, except in the Seward and Pistolet Subgroups. Red arkoses of the Seward Subgroup are discoloured in a 100 feet thick zone above and below gabbro sills, and show strong recrystallization. Dolomites of the Dunphy Formation have been converted to calc-silicate marbles, e.g.

north of Effiat Lake. Dolomitic shales with dolomite lenses of the Lace Lake Formation were converted to tremolite-talc schists northeast of Otelnuk Lake and north of Dunphy Lake. Dolomite conglomerates at Lac Ribeiro that belong either to the Dunphy or to the Bacchus Lake Formation have been converted to talc schists and actinolite schists.

At a few localities contact metamorphic effects were noted in pelitic rocks at the contact of gabbros. Northeast of Otelnuk Lake rounded porphyroblasts occur in shales. The porphyroblasts are now replaced by chlorite and sericite; their shapes suggest that they were originally andalusite and cordierite. Similar porphyroblasts have also been noted at the contact of thin shale beds with basalt flows.

Adinolization is much more common at the contact of gabbro sheets than normal iso-chemical contact metamorphism. The adinoles are light green well laminated rocks with dark green spots. They are now composed of albite, epidote, quartz, minor sericite, chlorite and actinolite. The adinoles are rich in soda that has been introduced during contact metamorphism.

The normal gabbro sheets show a regular differentiation depending on the thickness of the sheets. A chilled marginal zone, not more than 10 feet thick, is very fine-grained and indistinguishable from basalts. The upper chilled zone contains amygdules filled with quartz or feldspar at many localities.

The chilled phase grades rapidly into an ophitic facies. Not uncommonly a basal portion of the ophitic textured gabbro is enriched in olivine. The grain size of the ophitic facies increases regularly toward the upper centre of the sheets. Sheets exceeding 200 feet thickness have blotchy, irregular segregations of coarse-grained (1 or several cm) gabbro pegmatite in the upper centres. Extremely thick sheets (thickness about 2000 feet) finally contain veins or locally irregular segregations of granophyric material. These various types of the normal gabbros are briefly described in form of table 15. The reader is referred to Baragar (1960, 1967) for more detailed description.

Slightly metamorphosed gabbros are composed of actinolitic hornblende, plagioclase, epidote, and minor ore minerals. Diopside occurs here and there as relicts included in hornblende.

Xenomorphic crystals of magnesia rich <u>diopside</u> were observed in a few thin sections. Its optical properties are listed in table 10. Twins parallel (010) are common. Diopside has been largely replaced by hornblende and by chlorite.

Three loosely defined generations of colourless <u>hornblende</u> or of a dirty olive to blue green hornblende were distinguished. Their optical properties are listed in table 10.

Table 15 Description of the facies of the normal gabbros

	colour	petrography
chilled facies	dark to light grey	fine-grained mesh of diopsidic augite, orthopyroxene (generally chloritized), ± olivine (chloritized or serpentinized) clouded by sphene and magnetite
porphyritic facies	medium grey feldspar dark grey, white weathering	ophitic pyroxenes (orthopyroxene and diopsidic augite) up to 1 cm diametre, including plagioclase laths. Some plagioclase phenocrysts. Serpentine blebs derived from olivine. Titanomagnetite in ± skelettal crystals. Modal: olivine: 2-15%, pyroxene: 20-30%, magnetite: 5%, plagioclase: 50-60%
ophitic facies	mottled greyish	ophitic pyroxene (orthopyroxene and diopsidic augite) up to 3 cm. Plagioclase laths up to 1 cm long. Ilmenite, sphene form intergrowths in skelettal shapes. Modal composition: augite: 20-40%, olivine: 0-10%, plagioclase: 45-60%, ore minerals: 1-5%
pegmatitic facies	relatively dark coarse-grained pg-augite rock	augites elongated tabular crystals, commonly bent and twisted, up to 6 cm long. Thickly tabular plagioclases. Knots of quartz. Interstitial chloritic mesostasis and micropegmatite. Much iron ore. Modal composition: plagioclase: 35-50%, quartz: 5-30%, augite: 20-40%, mesostasis: 5-15%, ore minerals: 5-10%, micropegmatite: 0-30%
granophyr veins	light cream coloured	very fine-grained intergrowth of quartz, albite, with scattered actinolite, epidote and ore minerals. Some sulphides. Modal composition: albite: 50%, quartz: 30-40%, actinolite + chlorite: 5-10%, ore minerals: 1-5%, others: 1-5%

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The oldest generation of hornblendes (hornblende I) form large xenomorphic crystals replacing pyroxene. The replacement starts at the boundary and at cleavage cracks of pyroxene. Hornblende I has its (010) plane and c-axis (001) parallel to those of the pyroxene it replaces. It outlines the replaced pyroxene crystals exactly; the ophitic or intersertal textures are therefore preserved where pyroxene has been replaced by hornblende I. Hornblende I shows occasionally twins intergrown parallel to the (010) plane; these are probably derived from diopside twins replaced by hornblende whose (010) plane and (001) axis are parallel to those of the original pyroxene. Fine lamellar inclusions of chlorite parallel to the basis are common, and probably replace lamellae of orthopyroxene or of pigeonite.

Hornblende II forms short more or less xenomorphic prisms. It replaced the relicts of augite within hornblende I and is not oriented.

Hornblende III is present as thin fibrous needles or thin prismatic crystals, often in radiating sheaf-like aggregates. It grows as a "beard" on hornblende I and hornblende II and forms independently in other minerals of the rock. Parts of hornblende III may have a blue green or greenish blue colour. These barroisitic hornblendes are always in contact with albite; they appear to be slightly sodic and probably formed by reaction of amphibole with feldspar.

The size of the hornblende I crystals is equal to the size of the original pyroxenes of the gabbro. The differences in grain size and habit between amphiboles of the three generations therefore decrease with decreasing grain size, and they become indistinguishable in fine-grained varieties.

The optical properties of the hornblende I crystals (table 16) do not lie on the curves for actinolite (Tröger, 19). Chemical analysis leave no doubt that they actinolitic hornblendes (table 17).

Plagioclase is present as laths between hornblende I. It is commonly an albite (An_{05-10}) or oligoclase (An_{25-35}); relicts of bytownite (An_{60-65}) were observed in a few sections. They are full of clinozoisite which are finely intergrown with chlorite and leucoxene. The boundary of the plagioclases is usually free of clinozoisite. Plagioclase is partly replaced by hornblende III, and by chlorite which fills irregular caverns.

The intersertal matrix between the hornblende I and the plagioclase laths consists of chlorite, quartz, epidote, albite, and a little amphibole III.

Chlorite replaced parts of the intersertal matrix and fills caverns in plagioclases. In some sections it replaced the relicts of augite included in hornblende I.

Sphene and opaque minerals form ophitic grains and

Table 16

Optical properties of pyroxene and amphibole of metagabbros

Diopside

$2V_z$	$Z \angle c$	remarks
60	34	colourless
56	34	colourless

Hornblende

$2V_x$	$Z \angle c$	remarks	with plagioclase
84	12	colourless, intergrown with pyroxene with parallel b and c-axes	
80	16	colourless	An_{60-65}
90	10	colourless	An_{30}
80	12		
79			
82	10	Z very light bluish green	
74	10		
72	15		
70	17		
72	19		
76	18	Z light blue green	
68	14		
70	17		
76	14		
66	14		An_{05}
72	12		
74	14	Z blue green	An_{10}
72	12		
72			
60	13		
80			

Table 17

Composition and optical properties of hornblende in metagabbros of the Labrador trough

	B 4-5	A 35-7	cutions on basis of 230-atom	B 4-5		A 35-7	
SiO_2	54.87	48.01	Si	7.89	8.00	7.29	8.00
Al_2O_3	1.71	6.46	$[AL]^4$	0.11		0.71	
Fe_2O_3	4.20	2.76	$[AL]^6$	0.18		0.42	
TiO_2	0.48	0.61	Fe^{III}	0.45	0.68	0.31	0.80
FeO	11.42	16.58	Ti	0.05		0.07	
MgO	12.55	9.85	Fe^{II}	1.37	4.08	2.10	4.34
CaO	11.44	10.34	Mg	2.71		2.24	
Na_2O	0.58	0.85	Ca	1.76		1.67	
K_2O	0.10	0.13	Na	0.16	1.94	0.22	1.91
H_2O	2.15	3.31	K	0.02		0.02	
Total	99.50	98.90					

	B 4-5	A 35-7		B 4-5	A 35-7
n_x	1.633	1.641	actinolite	0.77	0.58
n_y	1.644	1.653	tschermakite	0.14	0.30
n_z	1.651	1.663	glaukophane	0.09	0.12
n_z-n_x	0.018	0.022	$\frac{Mg}{Mg + Fe^{II}}$	0.66	0.52
$2V_x$	71°	85°			
$Z \wedge c$	21°	22°	$\frac{Fe^{III}}{Fe^{III}\ [AL]^6}$	0.72	0.43

include feldspar laths. Long prisms of apatite are common. Small grains of calcite are present in the groundmass. Minute flakes of biotite were observed in some sections.

The amphibolitization of the gabbros proceeded under static condition and is due alone to the introduction of water into the rocks: In a few sheets the amphibolitization is not complete; in these the rocks at the margin of the sheets have been converted entirely to amphibolites, whereas relictic pyroxene and plagioclase is still present in the centres of the sills. The anorthite/albite ratio of the rocks decrease therefore toward the margins of the sheets, and the chlorite content increases in the same way.

Gabbros with quartz-dioritic or oligoclasitic differentiates

Parts of some gabbroic sheets have quartz-dioritic or oligoclasitic differentiates at the top. This appears to be a local variety of sheets that normally show the type of differentiation described above. Sills north of Lac Musset have a light grey fine-grained quartz dioritic sheet at the top. The quartz diorite is composed of laths of albitic feldspar, quartz, and minor actinolite, chlorite and ore minerals.

Some sheets north of d'Argent Lake contain irregular masses of oligoclasitic material that grade imperceptibly into the normal metagabbro. The oligoclasite is composed essentially of medium-grained thick and plump oligoclase laths, up to 5 mm long, with little interstitial amphibole and calcite. It grades into gabbro though increase of the actinolite content.

Glomeroporphyritic gabbros

Glomeroporphyritic gabbros, containing rounded blebs of plagioclase 5 mm to 15 cm across, are a characteristic phase of the Labrador trough magmatites. They occur in the Menihek Formation, between Low Lake and House Lake. The sheets of glomeroporphyritic sills are between 500 and about 2000 feet thick. The sills have been described in detail by Baragar (1960; 1967) and by Frarey (1967).

Simple glomeroporphyritic sheets have a chilled marginal phase, about 10 feet thick, of basaltic composition. The marginal phase grades rapidly into an ophitic gabbro with dispersed feldspar aggregates up to 10 mm across. This phase occupies a zone of about 30 feet thickness. It grades rather abruptly into the glomeroporphyritic facies that contains closely packed feldspar aggregates of 10-150 mm diameter with an interstitial matrix of a coarse-grained, feldspathic gabbro. Generally the feldspar aggregates are about 15-30 mm across. Layering due to variations of the size and density of the feldspar aggregates is a rare feature.

The feldspar aggregates are composed of intergrown nearly equidimensional plagioclase crystals that are extensively altered to albite, sericite, prehnite and epidote.

Smaller plagioclase laths in the groundmass are zoned; they are ophitically enclosed in diopside or in actinolitic hornblende derived from diopside. Iron ore is an accessory mineral in the interstitial gabbro. Interstitial quartz occurs.

More common are sheets in which glomeroporphyritic gabbros have complex relationships to ophitic gabbros. Baragar (1967) described cases in which glomeroporphyritic gabbros fill the upper and lower part of a sheet whereas the centre is occupied by ophitic gabbro. The upper and lower contacts of such complex sills are as described above. Contacts between the glomeroporphyritic phase and the ophitic phase are abrupt, but not absolutely sharp. The ophitic phase appears to be continuous with the matrix of the glomeroporphyritic facies. Lenses and schlieren of glomeroporphyritic gabbro occur not uncommonly in the ophitic gabbro. In some cases a transitional phase composed of small feldspar aggregates loosely set in the normal gabbro separates both facies and is bounded by rather abrupt gradations against both.

The writer (1971a) observed cases at Bacchus Lake where the normal gabbro occupies the top of the sheet. Alternating zones, ca 10 m thick, of glomeroporphyritic, transitional, and ophitic gabbro,occur locally. The glomeroporphyritic zones lens out laterally. All contacts are quite abrupt, but are not marked by chilling or grain size variations indicative of multiple intrusion. Layering of the glomeroporphyritic phase is rare.

Baragar (1967) suggested for petrochemical reasons that the glomeroporphyritic feldspar aggregates formed intratelluric. The relationships between the glomeroporphyritic phase and the gabbroic marginal phase in simple sills were interpreted as due to dynamic flowage differentiation. This interpretation is in good agreement with experimental work as Bhattacharji and Smith (1963) could show that solid particles dispersed in a moving liquid tend to concentrate in the centre of the conductor.

The relations between the glomeroporphyritic phase and the ophitic phase in complex sheets were interpreted by Baragar (1967) as being due to multiple intrusion. The writer (1971a) believes that this hypothesis does not account well for the observed structures. Chilled contacts between the glomeroporphyritic and ophitic phases have not been observed; on the contrary the ophitic phase appears to be continuous with the interstitial matrix of the glomeroporphyritic gabbro. Furthermore transitional phases exist here and there that are obviously genetically related to the main facies, and form a link between them. It has therefore been proposed to modify Baragar's hypothesis by assuming that the glomeroporphyritic feldspar aggregates were concentrated at the top of the magma chamber. At eruption the glomeroporphyritic magma would be injected in the sills first, and would undergo dynamic differentiation. Later during the eruption the still liquid glomeroporphyritic sheet would be re-intruded by normal gabbro magma. Finally some gravitative crystal settling and possibly laminar flow at late intrusive stages could explane the evolution of local layered zones.

Spilitic gabbros

Gabbros of spilitic composition form a prominent system of sills north of Minowean Lake, and partly spilitized gabbro sheets have been observed northeast and southwest of Coussinet Lake. It is very difficult to judge whether and to which degree spilitic gabbros occur elsewhere, because they can be recognized with certainty only by chemical analysis.

Fresh spilitic gabbros are distinguished from fresh tholeiitic gabbros by their light greenish grey colour and a greasy gloss that contrasts with the dull grey colour and sharp fracture of the fresh tholeiites. Varieties containing amphibole instead of pyroxene are indistinct. In thin section the spilites are characterized by the presence of oligoclase on the one hand, and the absence of epidote on the other. Tholeiitic gabbros of course contain considerable epidote if their plagioclase has been replaced by oligoclase.

Spilitic gabbro sheets show the same type of zonation as do tholeiitic sheets. Most sheets are quite thin; therefore pegmatitic phases are not present in all sheets and granophyr veins are absent.

The chilled facies of the spilitic gabbros is composed of a fine mesh of chlorite, albite, actinolite, diopside, and calcite clouded by sphene. The ophitic facies consists of ophitic diopside and ophitic patches of chlorite (after orthopyroxene?) encluding lath-shaped oligoclase crystals. Oligoclase is corroded by chlorite and partly replaced by prehnite. Altered ilmenite and chlorite patches probably replacing olivine are subordinate constituents.

Trachydoleritic gabbros

A sill of a trachydoleritic gabbro intruded rocks of the Ferriman and Pistolet Subgroups southwest of Hematite Lake. The sill follows generally the contact between the Wishart Formation and the underlying Pistolet Group. In detail it crosscuts stratification of underlying rocks. The sill also intersects a thrust fault southwest of Luche Lake; it has been folded and sheared but not to the same degree as its country rock. The writer therefore suggested that the sill intruded at an early syntectonic stage. The sill occurs in an important zone of synsedimentary faulting, and it has been inferred (Dimroth 1971) that it is related to the Luche-Girafe fault zone that formed at an early stage of the history of the Labrador trough.

The trachydolerite has a chilled contact facies that is a fine-grained green chloritic rock. Toward the centre it grades into ophitic quartz gabbro with red brown feldspar laths several mm long ophitically included in greenish black mafic minerals. The upper centre contains pegmatitic patches composed of red plagioclase and dark green chloritic mafics in the shapes of long prismatic crystals.

The chilled facies is composed of a fine-grained unoriented mesh of chlorite, actinolite, albite, feldspar and sericite, clouded by finely distributed sphene. The ophitic facies contains ophitic diopside, acid plagioclase that includes hematite dust in zonar arrangement, chlorite, actinolite, ilmenite, and sphene.

PERIDOTITE SHEETS

Peridotites occur in three settings in the Central Labrador trough: (1) Complex peridotite-gabbro sills occur in the Thompson Lake and Willbob Formations. The main sill is close to the top of the Thompson Lake Formation, or in the basal part of the Willbob Formation; it can be followed, with some interpretation, for over 120 miles. (2) Thin (50 feet or less) lenticular sheets of peridotite are here and there intercalated between the Willbob Basalts. (3) Lenses of ultramafic rocks, up to 200 feet thick and several miles long occur in the Laporte Schist in the extreme east of the trough.

The types (1) and (2) are partly serpentinized and, in folded and sheared zone, have been converted to talk schists. On the whole, however, they suffered only moderate deformation and metamorphism, and their contact relations are well preserved. Relictic olivine is common in the cores of the sheets. Type (3) is strongly deformed and its contact relations are virtually unknown due to poor outcrop. They have been strongly metamorphosed and have been converted to tremolite schists or to tremolite-olivine schists. Fahrig (1952) studied a sill of type (1) and gives details on its composition differentiation, mineralogy and on the mineral orientation. The other two types of ultramafic rocks have not been studied in any detail. The reader is referred to Fahrig (1962), Baragar (1967) and Taylor (1969) for more detailed in formation.

Composite ultramafic-gabbroic sheets

The following description is partly based on Fahrig's (1962) observations. The composite sheets are between 50 and more than 2000 feet thick. They show a characteristic differentiation pattern: A basaltic basal chilled zone, about 10 feet thick grades rapidly upward in a green medium-grained actinolite rock with some relictic plagioclase. The ultramafic portion of the sill overlies the actinolite rock with rapid gradation within less than 1 m. The ultramafic portion may locally compose the whole sheet, but in general it is overlain by a gabbroic phase. The gradation from the ultramafic rock into the gabbro takes place within about one metre thickness. Repetition of ultramafic and gabbroic zones at the top occur locally but are not characteristic. An upper chilled phase occurs at the upper margin of the sill. Locally the ultramafic portion of the sill is in contact with overlying rocks; Fahrig (1952) describes contacts between peridotite and pillow basalts that are remarkably gradational.

The basaltic zone is fine-grained, structureless; its colour is dark greenish grey on the fresh surface and greenish grey at the weathered surface. It grades into the actinolite zone that is characterized by a knotty weathering due to actinolite crystals up to 1 cm in diameter that stand out. Generally the actinolite zone also weathers greenish grey, but patches are stained rust brown by iron carbonate. The major part of the ultramafic portion of the sheets weather ochre or red brown. It is generally even grained but portions of the sheets contain knotty actinolite crystals up to 1 cm across. The serpentinite has a striking pattern of parting planes, generally consisting of two systems. The main systems of planes continuous for one or a few metres, are spaced some cm apart and parallel the contacts of the sheets. The second system is formed by discontinuous parting planes spaced about a decimetre apart, oriented perpendicular to the first systems. Polygonal random systems of parting planes occur here and there, and locally there are transitions between both types of parting systems.

The ultramafic portion of the sheets grades rapidly into the overlying gabbro. An actinolitic phase, generally a few metres thick is at the contact and locally repetitions of actinolitic zones, 10 cm thick, alternating with serpentinite have been observed at the top of the ultramafic portion of the sill.

Tensional fractures are common in the ultramafic rocks. They are filled by serpentine, magnetite, or tremolite.

Fahrig (1962) has described alteration of ultramafic rocks to talc-carbonate-chlorite bodies. The alteration is related to deformation and transects all zones of the ultramafic bodies.

The ultramafic rocks were originally composed of between 50 and 60 per cent olivine that has been largely serpentinized. Considerable relictic olivine is present in the centres of the sheets. Olivine contains about 13-15 per cent fayalite. Olivine has a grain size of one to several millimetres. It is euhedral with rounded corners. Diopsidic augite forms crystals up to two cm across poicilitically enclosing olivines. Fahrig determined their optical properties as

Sign (+)

$2V = 52 \pm 2^{\circ}$

$N_B = 1.684 \pm .004$

$Z \wedge C = 42^{\circ} \pm 2^{\circ}$

indicating a magnesian diopsidic augite. The pyroxene is generally altered to actinolite and later to serpentine.

Typical mesh serpentine is the normal replacement of olivine and in places of tremolite, and is the major component of the rocks. Antigorite appears to be a late mineral replacing olivine and tremolite. Tremolite forms large crystals that are replacements of augite with parallel orientation of crystallographic b and c axes.

METAMORPHOSED EQUIVALENTS OF THE MONTAGNAIS GROUP

Amphibolites and subordinate chlorite schists underlie the northeastern portion of the Romanet Lake map area. They are interlayered with metasedimentary rocks (biotite-phyllites, biotite schists, biotite-garnet and biotite-amphibole schists, quartzites and chlorite schists). The aspect of the rocks changes considerably along and across the strike and it was not possible to map the minor variations. Coarse and fine to medium-grained amphibolites were, however, distinguished where this was possible, because this difference seems to reflect differences of the primary material.

The amphibolites are green, dark green or greenish black. They are always somewhat schistose, although nearly massive varieties are present. Well schistose varieties are of course abundant. The amphibolites contain veins and irregular blotches of pegmatitic and aplitic material, but are otherwise homogeneous.

Within the normal amphibolites a number of rare rocks were observed. These are:

1. Garnet amphibolites containing red garnet porphyroblasts and commonly brown cummingtonite
2. Biotite-calcite amphibolites
3. Calcite-epidote amphibolites
4. Glomeroporphyritic amphibolites

The garnet amphibolites vary considerably in structure and composition. All varieties from nearly normal amphibolites, containing only a little garnet to garnet-cummingtonite schists free of green hornblende occur. The garnetiferous amphibolites apparently form lenses and layers within the normal amphibolites.

The biotite-calcite and calcite-epidote amphibolites occur northeast of Preville lake in an area that has been brecciated and intruded by calcite veins. They seem to be a reaction product between the normal amphibolites or greenstones and the calcite veins.

The glomeroporphyritic amphibolites contain light greenish grey spots of 1 cm. diameter composed of altered plagioclase in a fine-grained amphibolitic matrix.

More or less massive greenstones, consisting largely of chlorite, were included with the amphibolites.

A few layers of chlorite schists are present southwest of Preville lake. They are green, well schistose, and commonly laminated. The schistosity is always folded.

Petrography: Three loosely defined types of the "normal" amphibolite can be distinguished in microscopic examination. These are:

1. Slightly recrystallized amphibolites with ophitic relict textures
2. Slightly recrystallized amphibolites without relict textures. This includes all fine-grained amphibolites
3. Well recrystallized amphibolites.

There is only a slight mineralogical difference between these amphibolite types and the basalts. Commonly the amphiboles of the amphibolites are darker than those of the basalts, and the colour intensity increases to the well recrystallized amphibolites. The extinction angle of the amphiboles in the amphibolites is commonly somewhat larger than in metabasalts. This is only a general rule, however, and the amphibole may be quite pale even in well recrystallized varieties. Optical properties of amphibole are listed in table 18.

The three amphibole generations of the metabasalts can still be distinguished in the coarser grained amphibolites. The difference between hornblende I and II however decreases, and the hornblende III is recrystallized to considerably thicker and relatively well shaped prismatic crystals. The ophitic plagioclases may be preserved in hornblende I. The outline of the ophitic plagioclases may be traced by clusters of albite granules and clinozoisite. The ophitic plagioclases themselves are, however, not preserved as crystals. Such ophitic relict textures were observed especially in amphibolites north of Villandré lake.

The clinozoisite of the amphibolite tends to form aggregates of many small prisms and grains. The plagioclases are granulated and relatively clear, in marked contrast to the metabasalts, where the plagioclase laths are preserved and are full of clinozoisite inclusions. Chlorite, calcite, quartz, apatite, sphene, and opaque minerals are subordinate.

Northeast of Preville lake the amphibolites are well recrystallized. The hornblende of these rocks is usually dark blue green and commonly belongs to one generation. Large hornblendes of the hornblende I generation may be present and are granulated. Hornblende is nematoblastic, has sharp grain boundaries and commonly is somewhat poikiloblastic. Plagioclase is in undeformed grains devoid of zonar structure. More or less polygonal quartz grains are present. Irregular tables of biotite were observed in a few sections and appear to replace amphibole. Light green prochlorite replaces amphibole from grain boundaries and in shapes similar to oleander leaves. Epidote, calcite, sphene, and opaque minerals are minor constituents.

The amphibolites with glomeroporphyritic relict texture contian blebs of plagioclase which are now replaced by clinozoisite, muscovite, and albite. The plagioclase blebs are about 1 cm in diameter and are set in a fine-grained amphibolitic matrix.

The garnetiferous amphibolites are always well recrystallized. They contain rounded porphyroblasts of red garnet, commonly idiomorphic. Cummingtonite is present as long prisms and needles, commonly in radiating sheaves intergrown with green hornblende. All varieties from well recrystallized amphibolites with some garnet porphyroblasts to garnet-cummingtonite schists without green hornblende were observed.

The chlorite schists consist of prochlorite, amphibole, albite, quartz and the usual accessories. They are laminated and very well schistose. Prochlorite and the fine amphibole prisms are perfectly oriented. The greenstones, included with the amphibolites, have the same composition than the chlorite schists. The chloritic groundmass is in rosettes. Unoriented amphibole prisms are set in the groundmass. Porphyroblasts of opaque minerals are commonly present.

The contacts between the amphibolites and the metagabbros are well exposed north of Villandré lake. There the amphibolitization of the metagabbro begins at the tops and bottoms of the sheets and from faults. In a narrow zone the margins of the sheets are already amphibolites, their centres still metagabbros. These zones were mapped as metagabbro-amphibolite.

Table 18

Optical properties of amphibole in amphibolites

		Cummingtonite	
$2V_x$	$Z \angle c$	remarks	with plagioclase
84	19	nearly colourless, high refractive index, high birefringence, strong dispersion of the optical axes	
94	19		
94	17		
96	16		
		Hornblende	
$2V_x$	Z c	remarks	
82	16	Z = very pale blue green; well recrystallized	
82	17		
76	20		
82	17		
82	10	Z = very light blue green; not recrystallized	
76	14		
74	20		
80	13		
80	15		
80	16		
78	13		
80	20	Z = grass green; well recrystallized	
84	12		
80	16		
70	23		
82	11		
76	16		An_{30-35}
72	18		
86	13		
72	15		
78	20	Z = dark blue green; well recrystallized	An_{25}
82	10		An_{25-30}
68	15		
80	16		

INTRUSIVE AND EXTRUSIVE ROCKS OF DOUBTFUL ORIGIN

Intrusive and possibly also extrusive basaltic bodies are exposed in rocks of the Knob lake Group at Romanet river, and east of Romanet lake at latitude 56°18', longitude 67°52' and west and south of Castignon and Chakonipau Lakes. Most of these bodies seem to be concordant to the surrounding sediments, although discordant contacts have been observed at latitude 56°25', longitude 67°57'. Most bodies are somewhat sheared fine- to medium-grained meta-basalts as they are described above. Others are very inhomogeneous "greenstones" which may change from coarse-grained amphibole rocks, epidote rich rocks, and biotite-schists into more massive basalts at short distance along and across the trend. Most of the meta-basalts northeast of Romanet river at latitude 56°22', longitude 67°46' are such "greenstones".

Basalt breccias

Basalt breccias were found at several localities along Romanet river. They are of two types:

1. A breccia composed of white quartzite fragments set in a green chloritic matrix occurs at the Delhi Pacific Mines property (lat. 56°24', long. 67°55').
2. A breccia of sharply angular argillite fragments in a basalt matrix is present at the lower rapids of Romanet river.

The quartzitic fragments of the first breccia consist of fine-grained chert in various stages of recrystallization. The quartz grains of the chert are amoeboid. Their size varies considerably between and within the individual fragments. Generally the grain size increases towards the boundaries of the fragments, but there are also coarser grained blotches within the fragments. These coarser grained portions of the fragments contain a considerable amount of plagioclase, occasionally up to 50%, in subidiomorphic crystals. A little calcite is present in the components.

The matrix of the breccia consists of fine needles of amphibole, prochlorite, biotite, some plagioclase, calcite and some crystals of sphene. The boundaries between components and groundmass is not sharp.

The argillite fragments of the breccia at the lower rapids of Romanet river are largely replaced by chlorite. They consist of a fabric of prochlorite rosettae with numerous tourmaline prisms. The tourmaline traces the old bedding of the rock, which is perfectly preserved. Some blebs of calcite are set in the chloritic groundmass.

These breccias are of an intrusive origin. Their discordant contacts are exposed. The matrix is sheared and metamorphosed and they are older than the Labrador Trough folding and metamorphism. The breccia at the lower rapids of Romanet river has been brecciated again together with its country rocks and cemented by pegmatitic material. The pegmatitic material is also sheared.

Andesite and quartz-diorite

Some small bodies of andesite and quartz-diorite are exposed south of Romanet river.

The andesites are hard and massive, fine-grained, dark grey rocks. The weathered surface is finely mottled because of the white weathering plagioclase. Biotite flakes cover some joint faces. The quartz diorite is medium-grained, grey to greenish grey with brown spots. Plagioclase and biotite are readily visible and some sulphides are present.

Well developed laths of oligoclase-andesine (An_{25-35}) predominates. Minute biotite flakes and particles of opaque minerals surround the plagioclases and fill the interstices between them. Quartz is subordinate. In blotchy domains the grain size of the andesite may be considerably larger than normal and may approach that of the quartz diorite.

The rocks are somewhat deformed. The plagioclases are bent, occasionally broken and show beginning granulation at the grain boundaries. The quartz diorite is somewhat more deformed than the andesites.

These rocks do not fit into the normal volcanic sequence of the area. The andesite and quartz diorite show astonishingly little deformation and metamorphism. Their contacts are not exposed, but it is quite conceivable that these rocks are relatively late and that they intruded during the last stages of the Labrador Trough orogenesis.

PETROCHEMISTRY OF THE MAGMATIC ROCKS

General statement

Baragar (in Dimroth et al., 1970) has presented a general account on the petrochemistry of the basaltic rocks of the Labrador trough, from which the following statements are extracted. The magmatic rocks of the Labrador trough belong to two contrasting magmatic suites defined by their geological properties, by the contrasting characters of the magma types, and by their differentiation.

(1) The serpentinites, the tholeiitic, spilitic and glomeroporphyritic gabbros and the basalts of the Bacchus Lake, Menihek, Murdock, Thompson Lake, and Willbob Formations belong to a eugeosynclinal ophiolite suite (Baragar, 1960, 1967). Extrusive rocks of this suite are submarine fissure extrusious associated with shale-wacke suites deposited in a marine environment. Intrusive rocks are sills. The rocks are derived from tholeiitic magmas akin to oceanic tholeiites characterized by low Ti, P, and alkalies and by extremely low potash contents. They suffered relatively minor iron-enrichment differentiation. Rhyolites in the Murdock Formation are a special case and cannot be explained by the normal differentiation of the ophiolites.

(2) The trachydolerite and the trachybasalts of the Chakonipau Formation and Ferriman Subgroup belong to a miogeosynclinal magmatic suite. Extrusive centres were in part

sub-aerial and explosive activity was prominent. The rocks are associated with continental fault basin deposits (Chakonipau Fm) or with marine orthoquartzites and ironstones deposited in shallow water under stable tectonic conditions. The rocks are derived from a saturated alkaline magma suite with high contents in alkalies, P, and low lime. K/Na ratios are much higher than in the ophiolitic suite.

Ultramafic rocks

Fahrig (1962) analysed a composite sample of an ultramafic sill and presented a diagram showing the variation of Fe, Mn, Al, Ca, Cr, Ni, and Ti across an ultrabasic sheet based on spectrochemical data.

Tholeiitic gabbros

Baragar (1960, 1967) and Dimroth (1971) investigated the differentiation within certain sill groups of the Central Labrador trough. Sauvé (1957) and Sauvé and Bergeron (1965) used similar data in the northern trough. Hardy (1969) and Ott (in preparation) took systematic samples across several gabbroic sheets and investigated their differentiation. The analyses presently available in the area are listed in table 19.

Table 19 Chemical analyses of Labrador trough magmatites

		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O^+	H_2O^-	CO_2	S	tot.
	Archaean diabase dyke, west of Apollon Lake																
1	6-4-2	49.79	1.70	10.39	2.89	11.72	0.38	7.19	8.27	2.83	1.72	0.16	2.56	0.04	0.02	0.15	99.81
	Ophiolites																
	Serpentinite																
2	26-2-5	39.08	0.20	4.01	6.19	6.92	0.24	29.84	2.73	0.09	0.04	0.05	10.05	0.15	0.18	0.09	99.86
	Tholeiitic gabbros, Otelnuk Lake																
3	A 31-5	48.48	0.45	13.18	1.93	7.63	0.23	11.35	13.33	1.26	0.30	0.10	1.40	0.04	0.04	n.d.	99.72
4	A 15-1	49.12	0.58	16.12	2.15	6.21	0.21	7.23	12.60	2.34	0.52	0.03	2.57	0.06	0.05	n.d.	99.79
5	B 41-5	49.88	1.09	14.32	1.78	9.89	0.22	7.86	11.72	2.19	0.18	0.04	0.50	0.10	0.00	0.11	99.87
6	A 15-5	49.12	0.77	15.55	3.95	6.38	0.21	6.59	12.20	2.56	0.54	0.06	1.85	0.07	0.05	n.d.	99.90
7	B 17-5	49.09	0.96	14.04	3.33	8.57	0.24	7.10	10.62	2.21	1.00	0.03	2.46	0.07	0.12	0.15	100.00
8	A 15-3	49.44	1.17	12.92	2.75	10.32	0.26	6.27	11.61	2.36	0.70	0.07	1.71	0.05	0.04	n.d.	99.67
9	A 28-1	45.22	1.84	11.70	7.15	12.02	0.22	5.95	9.95	2.40	0.57	0.02	2.62	0.11	0.06	0.14	99.97
10	A 15-2	46.80	2.90	11.03	4.99	16.65	0.37	3.55	8.10	2.86	0.62	0.12	1.78	0.09	0.02	n.d.	99.88
11	A 19-13	62.83	1.30	10.65	6.30	4.89	0.15	1.34	6.68	4.11	0.11	0.20	1.07	0.10	0.18	0.11	99.92
12	A 14-1	56.29	0.48	10.88	7.68	5.95	0.19	1.32	13.30	0.42	0.22	0.64	1.64	0.05	0.15	n.d.	99.21
13	A 15-14	66.49	0.57	9.53	2.92	8.08	0.12	1.81	4.15	3.75	0.05	0.09	1.40	0.07	0.99	0.04	100.06

3-10 = ophitic gabbro; 11-12 = pegmatitic gabbro; 13 = granophyr;
12 = epidotized.

		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O^+	H_2O^-	CO_2	S	tot.
	Tholeiitic gabbros, Mistamisk Lake																
14	A 7-4	51.01	0.57	14.96	0.76	5.70	0.15	8.03	12.05	3.03	0.46	0.01	2.85	0.07	0.03	0.04	99.72
15	A 35-6	46.44	0.58	17.15	1.15	7.80	0.15	9.74	12.41	1.39	0.82	0.005	2.58	0.10	0.00	0.03	100.34
16	B 9-5	48.06	0.66	15.00	1.54	8.26	0.16	9.84	12.17	1.54	0.16	0.01	2.22	0.06	0.06	0.06	99.80
17	A 35-8	48.63	1.05	14.28	2.21	8.14	0.19	8.30	12.04	1.47	0.28	0.01	3.09	0.06	0.02	0.10	99.87
18	A 39-19	48.72	1.02	14.17	2.28	8.49	0.22	7.91	11.51	1.41	0.18	0.14	3.47	0.10	0.32	n.d.	99.94
19	B 9-6	49.60	1.34	12.39	3.05	9.93	0.20	6.94	11.00	3.02	0.12	0.03	2.44	0.08	0.00	0.09	100.23
20	G 12-60	49.57	1.24	12.74	2.67	10.65	0.26	6.36	11.07	2.22	0.11	0.09	2.68	0.09	0.00	0.04	99.69
21	A 35-7	49.82	1.48	12.72	2.97	10.96	0.26	5.92	9.89	2.84	0.12	0.11	2.84	0.07	0.00	0.03	99.89
22	B 4-4	49.92	1.31	15.09	6.77	6.93	0.19	4.74	8.29	2.76	0.74	0.09	3.18	0.08	0.03	0.07	100.19
23	B 4-5	48.10	3.22	9.20	12.84	8.66	0.23	4.33	7.87	3.44	0.13	0.07	1.42	0.09	0.00	0.22	99.82

14-16, 19-22 = ophitic gabbros; 17-18 = chilled gabbro; 23 = pegmatitic gabbro.

251(2)

n Lake area, normal gabbros

24	B 279	46.06	0.[illegible]	17.86	1.29	7.81	0.[illegible]7	10.58	10.68	1.37	0.23	0.23	3.26	0.25	0.01	0.01	100.40
25	B 295	45.67	0.[illegible]	16.68	1.40	8.55	0.[illegible]8	10.24	10.67	1.44	0.10	0.05	3.99	0.36	0.08	0.07	100.21
26	R 900	49.12	0.75	13.77	1.17	8.33	0.20	9.71	13.18	1.34	0.05	0.05	2.20	0.16	0.05	0.06	100.27
27	R 189	44.50	0.77	18.90	1.26	7.74	0.18	7.99	12.17	1.80	0.26	0.03	3.76	0.25	0.01	0.02	99.70
28	B 345	46.95	0.80	17.92	1.48	7.77	0.20	7.15	8.55	1.86	0.32	0.12	3.09	0.20	0.01	0.03	100.05
29	R 129	48.99	1.39	12.42	2.61	12.74	0.25	7.41	10.94	2.34	0.12	0.00	3.73	0.09	0.00	n.d.	100.64
30	B 286	49.97	0.76	13.44	2.00	11.42	0.26	5.74	10.75	2.19	0.28	0.11	2.82	0.12	0.27	0.15	100.17
31	R 127	50.10	1.31	12.83	2.07	12.17	0.23	5.93	10.37	2.30	0.12	0.00	2.57	0.09	0.00	n.d.	100.47
32	R 195	44.48	2.81	11.44	1.19	17.46	0.26	6.16	10.39	1.71	0.31	0.06	3.03	0.24	0.04	0.18	99.74
33	R 93	46.73	2.86	12.05	2.25	14.66	0.28	5.57	7.19	1.83	0.48	0.30	2.62	0.11	0.00	n.d.	100.13
34	R 151	48.82	2.33	12.25	4.01	13.88	0.26	3.76	4.26	4.26	0.01	0.10	3.34	0.43	n.d.	n.d.	100.64
35	R 94	50.12	2.59	10.83	1.96	18.16	0.24	2.97	6.59	2.76	0.19	0.59	4.08	0.35	0.22	0.17	99.65
36	R 554	54.02	2.08	11.15	1.44	16.19	0.36	2.36	7.90	2.57	0.18	0.25	3.02	0.00	0.00	n.d.	100.21
	24-28 = porphyritic and ophitic gabbros; 31-32 = even grained gabbro; 29-30, and 36 = subpegmatitic gabbro and gabbro pegmatite; 33-35 = albite gabbro pegmatite																
	Cramolet Lake, granitic veins																
37	BL 9-227	63.09	1.76	13.13	0.49	2.01	0.06	1.36	7.90	5.82	0.04	0.21	0.68	0.04	3.18	n.d.	99.82
38	BL 9-206	74.16	0.27	12.47	1.09	1.32	0.08	0.66	2.50	5.97	0.04	0.04	0.54	0.14	0.38	n.d.	99.86
	Metagabbros, Ahr Lake and Thompson Lake areas																
39	R 337	44.88	0.76	13.73	1.10	8.61	0.17	14.34	8.66	1.95	0.06	0.25	4.91	0.11	0.09	0.06	99.66
40	R 293	46.77	0.39	23.09	1.42	4.24	0.07	6.64	12.55	2.66	0.10	tr.	1.92	0.00	n.d.	n.d.	99.84
41	46-50, 6-50	50.60	0.28	9.78	1.08	9.68	0.12	11.81	11.73	1.88	0.34	0.08	1.89	0.11	0.00	0.10	99.51
42	B 71	52.61	0.93	13.57	0.98	7.84	0.21	8.82	7.80	3.90	0.14	0.09	2.62	0.13	0.00	0.00	99.67
43	121-50	49.20	0.74	14.15	5.12	10.95	0.09	4.99	8.73	2.56	0.75	0.24	1.46	0.31	0.36	0.18	99.91
43	202-50, 159-50	46.90	0.84	18.19	3.58	7.71	0.07	6.20	11.23	1.60	0.53	0.23	2.24	0.18	0.27	0.16	99.93
	Glomeroporphyritic gabbros, Ahr Lake area																
44	R 161	48.03	1.58	14.87	0.84	12.27	0.14	7.15	5.88	2.05	2.62	0.21	4.02	0.27	0.00	0.03	99.98
45	R 163	48.92	1.56	16.35	0.81	12.60	0.19	3.82	9.75	2.26	0.46	0.08	2.63	0.08	0.05	n.d.	99.56
46	R 177	47.43	0.91	20.57	1.33	7.44	0.15	4.08	11.32	2.80	0.57	0.10	2.85	0.19	0.00	0.03	99.77
47	R 181	45.71	0.25	29.04	2.11	0.74	0.03	1.38	14.22	2.63	1.23	0.03	2.56	0.17	0.00	n.d.	100.10

44 = chilled contact; 45 = 2 feet from contact; 3 = groundmass; 4 = feldspathic aggregate

Tholeiitic basalts, Coussinet and Mistamisk Lakes

251·(3)

48	W 10-9	46.50	0.91	14.11	2.18	9.48	0.79	8.83	12.29	1.55	0.09	0.06	3.48	0.06	0.00	0.03	99.67
49	W 10-6	49.23	0.96	14.44	1.85	8.70	0.16	7.74	11.21	2.52	0.13	0.07	2.82	0.07	0.00	0.07	99.97
50	G 10-39	48.42	0.91	14.30	2.54	8.94	0.23	7.89	11.30	1.85	0.17	0.06	3.25	0.04	0.03	n.d.	99.93
51	P 7-2	48.28	1.10	14.03	2.17	9.54	0.23	7.67	11.60	1.86	0.22	0.08	3.07	0.12	0.02	n.d.	99.99
52	P 7-3	50.06	1.33	13.65	1.66	10.42	0.22	7.34	6.86	3.10	0.24	0.10	3.84	0.06	0.37	n.d.	99.25
53	G 11-47	49.84	0.98	13.35	2.76	9.47	0.23	7.17	10.41	2.38	0.22	0.10	3.10	0.05	0.06	n.d.	100.12

Tholeiitic basalts, Ahr and Doublet Lakes

54	B 54A	48.52	1.28	14.36	1.40	11.34	0.22	7.33	10.21	2.05	0.24	0.09	2.88	0.21	0.06	0.06	100.19
55	Composite	48.86	0.53	15.07	2.39	9.63	0.37	6.34	9.64	1.76	0.43	0.20	3.18	0.34	tr.	0.15	99.89

Tholeiitic basalts, Retty Lake

56	W/o No	47.60	1.12	13.30	2.62	12.58	0.22	7.04	9.58	2.01	0.27	0.11	2.88	0.14	0.22	0.11	99.80
57	W/o No	48.11	1.15	13.75	0.90	13.50	0.22	6.53	9.83	2.05	0.33	0.12	2.84	0.06	0.18	0.11	100.18
58	W/o No	45.68	1.33	13.70	6.50	11.30	0.22	6.02	10.00	1.80	0.39	0.14	2.80	0.05	0.08	0.17	99.67
59	W/o No	48.07	1.12	13.70	3.17	10.73	0.22	7.14	9.44	2.39	0.26	0.11	3.03	0.10	0.09	0.11	99.72

56 = massive basalt; 57 = pillowed basalt; 58 = glomeroporphyritic basalt; 59 = medium-grained basalt

Rhyolite, Murdock Formation

60	W/o No	72.3	0.50	12.6	4.7	0.6	<0.02	<0.5	0.1	2.9	5.0	0.09	0.8	–	<0.1	–	

Spilitic gabbros, Mistamisk Lake

61	P 13-4	44.36	0.67	15.80	2.35	10.21	0.31	10.84	5.65	3.23	0.31	0.04	5.74	0.21	0.23	n.d.	99.95
62	A 33-13	44.62	1.09	14.41	0.43	8.37	0.18	6.61	8.49	3.48	0.39	0.04	4.39	0.07	6.47	0.99	100.12
63	P 8-6	51.21	0.89	14.33	1.90	8.59	0.23	7.83	5.38	5.64	0.40	0.06	3.28	0.14	0.12	n.d.	99.99
64	A 29-8	51.28	1.35	13.39	1.75	11.20	0.24	6.50	6.92	3.41	0.65	0.14	3.24	0.04	0.04	n.d.	100.15
65	A 40-5	44.63	1.85	13.85	7.36	11.16	0.32	7.17	5.46	2.84	0.47	0.14	4.83	0.14	0.08	n.d.	100.30

61, 64, 65 = ophitic gabbro; 62, 63 = chilled gabbro

Spilitic gabbros, Minowean Lake

66	A 5-4	49.60	0.72	15.87	0.52	7.08	0.15	8.42	9.34	4.11	0.04	0.01	3.76	0.09	0.04	0.02	99.77
67	P 20-6	44.52	0.98	16.60	1.65	10.66	0.28	12.91	1.12	2.94	0.24	0.07	7.55	0.24	0.04	n.d.	99.83
68	P 24-1	49.90	0.68	15.60	1.28	7.44	0.20	8.34	8.12	4.15	0.52	0.04	3.59	0.16	0.05	n.d.	100.07
69	B 4-3	48.34	1.12	13.80	4.35	6.25	0.22	8.03	5.72	2.28	1.44	0.02	4.71	0.05	3.67	0.04	100.05
70	P 20-1	49.26	1.09	13.29	3.25	9.98	0.32	6.98	7.66	3.58	0.85	0.07	3.47	0.13	0.04	n.d.	99.94

66, 68, 70 = ophitic gabbro; 69 = chilled gabbro; 67 = altered

Spilitic basalts

251 (4)

71	B 9-4-3	46.36	1.16	15.30	0.81	8.65	0.19	9.38	6.55	4.80	0.06	0.06	4.36	0.07	2.35	0.15	100.25
72	P 7-4	53.94	1.06	11.03	1.37	8.42	0.22	8.74	8.60	4.12	0.24	0.05	2.24	0.08	0.04	n.d.	100.16
73	P 9-1	49.05	0.92	13.05	1.90	9.40	0.22	9.55	8.49	3.14	0.22	0.06	3.69	0.12	0.06	n.d.	99.87
74	A 34-8	49.00	0.9[illegible]	14.01	3.64	6.84	0.[illegible]	7.25	11.02	3.30	0.30	0.08	2.66	0.10	0.25	n.d.	99.62
75	25-3-7	46.10	4.[illegible]	12.50	6.42	9.18	0.10	5.64	6.22	4.90	0.73	0.43	2.[illegible]	0.05	0.09	0.14	99.71

75 = keratophyric (?) tuff

Miogeosynclinal magmatites

Trachydolerites, Hematite Lake

76	P 30-1	54.26	1.72	14.69	5.14	5.26	0.17	5.74	1.99	5.40	1.84	0.16	3.07	0.09	0.04	n.d.	99.97
77	P 30-2	53.58	1.64	14.30	9.33	4.27	0.15	4.17	2.32	5.90	2.00	0.13	2.38	0.13	0.03	n.d.	100.33

Trachybasalts, Lac Musset

78	18-1-11	49.66	1.27	13.95	11.16	3.08	0.21	3.98	4.21	4.90	2.76	0.13	2.40	0.06	1.95	0.09	99.72
79	18-1-12	49.02	1.38	15.47	7.87	5.33	0.22	3.42	2.79	4.80	4.50	0.14	1.96	0.06	2.12	0.09	99.87

Nimish tuffs, Knob Lake

80	KL-1	27.83	0.48	11.26	36.71*)		0.18	3.16	0.17	0.07	3.88	0.16	4.62	0.18	0.02	18.88	107.60*)
81		44.81	2.18	21.11	3.01	10.07	0.12	3.58	0.62	0.11	7.86	0.22	4.49	0.17	0.14	1.68	100.17
82		41.99	1.26	12.60	1.45	8.24	0,31	6.32	9.64	0.57	5.94	0.19	3.59	0.26	7.40	0.01	99.80

80 = pyritized tuff; 81 = Nimish tuff, probably mixed with sedimentary material;
82 = carbonate cemented tuff; *) iron as Fe_2O_3

Post-Hudsonian diabase

83	HRW-12	46.45	2.20	15.76	2.65	12.59	0.22	6.20	8.22	2.86	0.90	0.36	1.27	0.03	0.18	0.13	100.00

References: Baragar 1967: Analyses 24-47, 54; Fahrig 1962: Analysis 55; Girard 1965: Analyses 56-59; Dimroth 1970c: Analyses 2-23, 61-80; Dimroth et al 1970: Analysis 60: Zajac 1974: Analyses 81-82; unpublished: Analyses 1, and 83. Analyses 1-23, 48-53, 61-80, 83: Laboratories of the Quebec Department of Natural Resources.

The composition of the primitive magma is relatively constant lying very close to the plane of silica saturation of the basalt tetrahedron (diopside-olivine-nepheline-quartz). Minor variations of the intruding magma in composition exist. Some sills appear to be derived from very slightly olivine normative magmas, whereas others descend from slightly quartz normative magma; the mafic index of the primitive liquid also appears to be slightly variable, although it is generally around 55-62.

Differentiation in the sills is characterized by extreme iron-magnesia fractionation. Iron increases rapidly from the cumulate phases to the pegmatitic gabbros to decrease in the very last, granophyric differentiation stages. Magnesia decreases monotonously. Simultaneously the anorthite content of plagioclase decreases moderately. This has as effect a slight decrease of alumina in the last differentiation stages, and a monotonous decrease of lime and increase of alkalies during differentiation. Alumina is somewhat low in the earliest cumulate phases due to the high contents of mafic minerals. Potash is depleted during the differentiation, probably because the early high temperature plagioclase is enriched in potash relatively to the magma.

Iron oxidation, and with it the content of normative iron ores increases very strongly during the later differentiation stages. At the same time quartz appears. It is likely that the late enrichment of the rocks in quartz is linked to iron oxidation that leads to precipitation of iron oxides instead of iron silicates. This process has been experimentally established by Osborn (1959), and is believed to be petrogenetically important (for example Kuno, 1968).

Glomeroporphyritic gabbros

Very little chemical work has been done on the glomeroporphyritic gabbros. Available analyses (Baragar 1960; 1967) are quoted in table 19. They show that (a) the chilled marginal phase of the glomeroporphyritic sills corresponds to the normal gabbros and (b) the glomeroporphyritic phase is strongly enriched in alumina and lime. It is obvious that it is impossible to derive rocks of the composition of the glomeroporphyritic phases from the chilled liquid without subtraction of a ferromagnesian cumulate. This is absent from the glomeroporphyritic sills. It has consequently been inferred that the glomeroporphyritic feldspar aggregates are intratelluric (Baragar 1960, 1967).

Spilitic gabbros

Analyses of the spilitic gabbros are listed in table 19 and have been plotted on the same diagrams as the tholeiitic gabbros. It is clearly apparent that all oxides except for CaO and alkalies plot on the same trend lines as the tholeiitic rocks. Lime is consistently below the tholeiitic trend line, whereas alkalies are consistently higher than in tholeiites.

From this behaviour of the spilitic gabbros and from petrographic observations Dimroth (1971) has drawn the conclusion that the spilitic gabbros are derived from tholeiites by metosomatic base exchange. It has been inferred that the spilitization took place under more or less isochemical conditions except for addition of soda, water and eventually CO_2, and subtraction of lime. The reactions leading to spilitization are supposed to be:

(1) $CaAl_2Si_2O_8 + SiO_4^{4-} + Na^+ + 2H^+ \quad NaAlSi_3O_8 + Ca^{++} + AlO_3^{3-} + H_2O$

anorthite albite

and

(2) $5\ MgSiO_3 + 2\ AlO_3^{3-} + 5\ H_2O \quad Mg_5Al_2Si_3O_{10}(OH)_8 + 2\ SiO_4^{4-} + 2\ H^+$

enstatite Mg-Al-chlorite

Spilitization of gabbro sills proves that contact with sea water is not a necessary conditions of spilitization. It is likely that the spilitization occurred during a diagenetic stage by metasomatic reactions with ambient waters.

Basalts

The chemical analyses of basalts from the area

are listed in table 19. The basalts are tholeiites, either very slightly quartz normative or very slightly olivine normative. They show minor differentiation along the same differentiation trend as the gabbro. Spilitization of basalts is not uncommon and appears to affect particularly the basal and uppermost parts of flows. Compositionally the basalts are identical to the average of the chilled gabbros, a fact that substantiates that both are closely related. The glomeroporphyritic basalts have not been analysed.

Miogeosynclinal magmatic rocks

7 analyses of the miogeosynclinal magmatites are listed in table 19. The analyses are from three different suites: (1) Trachybasalts from Lac Musset occur in the Chakonipau Formation. The analysed rocks are massive flows intercalated in the mainly pyroclastic sequence. (2) Trachybasaltic agglomerates and flows erupted in the Astray Lake area, south of the zone described here, during deposition of the Ferriman Subgroup. Tuffs in the Ruth Formation (Analyses No 80 and 81) are probably volcaniclastic rocks derived from that volcanic centre. A third analysis (no 82) is from a calcite cemented agglomerate from Astray Lake. The analyses No 81 and 82 are from Zajac (1970). Analysis is from a pyritized volcaniclastic tuff, No 81 is from a volcaniclastic tuff that is probably either weathered or mixed with much sedimentary material. The other two analyses (No 76 and 77) are from the trachydolerite sill intruding Ferriman rocks southwest of Hematite Lake, and described on pages 174-175.

All analyses are characterized by high alkalies. The potash/soda ratio is moderately to extremely high. Lime is very low, except in the carbonate cemented tuff. Iron is highly oxidized and the iron/magnesia ratio is high. The chemistry of these rocks is in complete contrast to the chemistry of the eugeosynclinal ophiolites.

Comparison with oceanic basalts and with Alpine ophiolites

Baragar (in: Dimroth et al. 1970) compared the average composition of the Labrador trough basalts with oceanic basalts. An average of basalts of the Labrador trough is compared with the average of oceanic tholeiites in table 20. Their MgO/FeO + Fe_2O_3/Alkali ratios and the ratios CaO/Na_2O/K_2O are compared in figure. It is obvious that the average Labrador trough basalt is virtually identical with the average oceanic tholeiite, save for somewhat lower alumina.

Baragar (in Dimroth et al. 1970) compared the frequency distribution of the potash, soda and titanium contents, and of the differentiation and colour indexes of Labrador trough basalts with those of oceanic tholeiites. Both curves are very similar. The average of a suite of Alpine ophiolitic basalts is also similar, although these rocks are somewhat more spilitized. The average composition of Alpine ophiolites is more mafic, due to the predominance of ultramafic rocks in the Alpine ophiolitic suites. The Labrador trough basalts also suffered iron/magnesia fractionation during differentiation, a feature described from oceanic basalts by Miyashiro et al. (1970 a,b).

HUDSONIAN GRANITES AND PEGMATITES

Small outcrop zones of a massive biotite granite and of massive pegmatites have been mapped in the northeast of the Effiat Lake map area. The bodies have less than a thousand feet diametre. Their contacts do not crop out. The bodies are probably small stocks rather than dykes. The rocks are totally indeformed and are therefore believed to be post-Hudsonian.

A porphyritic biotite granite was observed southeast of Lac Marquiseau. It contains tabular phenocrysts of potash-feldspar 2 cm long, set in a medium-grained matrix of oligoclase, orthoclase quartz, biotite and muscovite. The pegmatite bodies are composed of very coarse-grained quartz and feldspar, locally in graphic intergrowth. Garnet and tourmaline were observed in some pegmatites.

There appears to be little doubt that the granite and pegmatites of the present area form part of a subordinate but characteristic suite of acidic intrusive rocks that occur in the highly metamorphosed easternmost zone of the Labrador trough (Fahrig 1957, Gold 1962, Gélinas, 1965). Their intrusion is post-kinematic relative to the folding of the intruded rocks, and concludes the Hudsonian Orogeny in the region.

LATE PRECAMBRIAN OR PHANEROZOIC

Few traces of the Post Hudsonian history remain within the present area. Diabase dykes are present in the immediate vicinity of Schefferville, and an intrusive-extrusive complex of alkali-ultramafic and carbonatitic rocks is present west of Castignon Lake. Dykes of both rock suites cut the Hudsonian fold structures. They are therefore younger than the Hudsonian orogeny. Data presently known do not permit further precision of their ages.

DIABASE

Several diabase dykes cut the formations of the Knob Lake Group south of 54°45'. Some dykes outside of the compiled area intersect the western boundary of the Labrador trough. The rocks are composed of a mesh work of plagioclase laths (An 70%) with interstitial olivine, violet titaniferous, pyroxene and opaque iron ore. An analysis is given in table 19.

CARBONATITES AND MEIMECHITES

Dikes and diatremes of carbonatitic and alkali-ultrabasic rocks occur in the area west and northwest of Castignon Lake. The suite was described in detail by the writer (Dimroth 1970a); the following discussion is briefed from this paper.

The volcanic rocks occur in an area extending about 10 x 20 miles in the west of the Brèche Lake and Lace Lake areas. They represent various levels of small volcanic structures. It is believed that the exposed levels in the north of the zone are rather shallow, whereas rather deep levels are exposed in the south. On the whole one can distinguish a northernmost zone, between Luche and Hematite Lakes, where we find the remnant of a tuff cone and presumably high levels of diatremes. A central zone, centered at Breccia Lake exposes presumably deep levels of diatremes and dykes that are discontinuous. A southern zone, centered at Savigny Lake, contains dykes of which some are longer than two miles, and that are interpreted as the roots of diatremes.

The carbonatitic and ultramafic volcanoes were highly explosive. Most of the extrusive tuffs, as well as all of the diatremes and some of the short dykes are filled by breccias. Most of the dykes in the southern zone, and some of the short dykes in the central zone have a filling of dyke rocks that contain few inclusions. Large shatter zones surround some of the diatremes in the central zone.

The volcanic rocks comprise all transitions between alkali-ultrabasic rocks of kimberlitic chemistry (meimechites) and carbonatites. On the whole the carbonatitic rocks predominate in the higher levels of the diatremes and the meimechites in the lower levels. However meimechitic lapilli tuffs do occur in the volcanic cone, and are probably extrusive; somewhat silicatic carbonatites, on the other hand, fill some of the dykes in the southern zone, The mineralogy of the carbonate depends also on the depth of crystallyzation of the rocks:

Calcite occurs only in the meimechite and carbonatite tuff breccia of the volcanic cone and in few diatremes in the northern zone, whereas ankerite is the dominant carbonate elsewhere.

The age of the carbonatites and meimechites is unknown. The diatremes intersect folds. They are generally localized in anticlinal zones; it appears that this is due to tectonic control of volcanic drilling, and that there is no genetic relation between the intrusion and orogeny. Dykes generally follow cleavage. Again there is one exception: one of the dykes southeast of Luche Lake follows more or less bedding in a synclinal fold. We believe that this dyke also intruded along a pre-existing zone of weakness. There is no evidence that it is folded. The breccias include commonly cleaved slates; neither breccias, dyke rocks, or the brecciated slates surrounding some diatremes show traces of folding. Some of the high level diatremes, however, are strongly faulted, and locally have even been brecciated. In this case also it is believed that the brecciation of the volcanic rocks is a late manifestation of the volcanic activity, and is not related to the Hudsonian orogeny.

Tuff cone: Remnant of a tuff cone was mapped 2 miles southwest of Hematite Lake. It is composed of an outer ring of carbonatite tuff breccia, an inner ring of meimechitic lapilli tuff, and an excentric carbonatite breccia pipe. The tuff breccia has been preserved only in the southwest of the cone. A sill of flow-layered carbonatite locally intruded at the contact between the tuff breccia and the underlying Labrador trough rocks.

Diatremes: The diatremes are round, elliptical and some cases irregularly shaped. Some diatremes formed by co-alescence of parallel dykes. A small diatreme, located about a mile east of the southeastern bay of Hematite Lake, consists of three partly coalescent sheet-like bodies trending northwest, separated by screens of the Sokoman Ironstone. Some parts of these screens are strongly brecciated.

At deeper levels some of the diatremes are surrounded by zones of shale breccias. The shale breccia consists of angular fragments of shale, without orientation. Striated fault planes crisscross the breccia, and bound the fragments. Here and there a little carbonate occurs in interstitial spaces between the fragments, but on the whole the breccia is well compacted. The writer inferred that this breccia formed by implosion of the stressed country rock into the diatremes during volcanic eruptions.

All diatremes are filled by breccias that contain fragments derived from the surrounding country rock, from rocks that are stratigraphically below (including the basement) and from rocks that were originally above the present level of erosion. Fragments derived from deep levels are generally rounded and small, whereas fragments derived from the surrounding country rock are angular, and relatively large (up to 1 cubic metre, generally 1 or 2 inches). Carbonatite fragments occur in many diatremes.

Breccias filling high levels of diatremes contain fragments in normal packing cemented by coarsely crystalline calcite. Breccias of slightly deeper levels are strongly compacted and have a matrix of finely ground carbonatite powder. In deep levels of diatremes the fragments are set in a carbonatite matrix.

Dykes: The dykes are up to 30 feet wide and apparently not longer than 300 feet in the central zone. They are filled with carbonatite cemented breccias or with massive carbonatite. Dykes of the southern zone are up to 100 feet wide. One of the dykes has been followed for more than 1½ miles; a prominent ridge, and occasional outcrop suggest that it is continuous for another mile and a half. The dykes are filled with biotite carbonatites and meimechites.

Petrography

All transitions from meimechites to carbonatites exist in the suite. All rocks are strongly altered. Meimechites, as they fill many of the dykes of the southern zone, are composed of serpentine, chloritized biotite, talc, chlorite, magnetite and more or less ankerite. Chloritized biotite forms large poikilitic crystals. Garnetiferous mica-peridotite fills one of the bodies in the northern zone. It contains serpentinized olivine phenocrysts, poikilitic biotite and garnet (hydro-grossular-andradite) in a very fine-grained mesh of essentially undeterminable minerals. Meimechitic lapilli tuff of the tuff cone southwest of Hematite Lake consists of pea size meimechite lapilli with a frange of chlorite cemented by calcite. The lapilli contain serpentinized olivine in a mesh of chlorite, serpentine, and iron ore.

Biotite and olivine carbonatites contain large poikilitic biotite blades and serpentinized olivine phenocrysts set in a groundmass of ankerite, chlorite, serpentine and iron ores. Other carbonatites are devoid of biotite and olivine. Some varieties contain carbonate phenocrysts several mm across set in very fine-grained matrix. The porphyritic facies grades into an even grained facies toward the centres of the bodies.

Meimechitic carbonatites are typical fragments in some breccias, in particular in the tuff breccia. They con sist of carbonate pellets several mm across set in a groundmass of chlorite, serpentine, carbonate and iron ores. Tabular pseudomorphs in the meimechitic carbonatite have the shape of melilite.

Apatite-fluorite carbonatite occurs 1 mile south of Lac de la Brèche. It contains ankerite phenocrysts 1-2 cm across, and apatite prisms up to 5 mm long set in a fine-grained mass of ankerite and iron ore. Fluorite fills many small vugs.

Flow layered carbonatites consist of carbonate with or without pellets of chlorite and serpentine, and show a somewhat irregular banding on a mm or cm scale parallel to the contacts.

The tuff breccias are well bedded; crossbedding occurs in fine-grained varieties. They contain fragments of Precambrian rocks that in certain layers may attain diametres of 10 cm. Generally grain sizes are between 1 mm and 3 cm. Coarse-grained beds consist essentially of Precambrian fragments, in particular Sokoman Ironstone, cemented by coarse-grained calcite. Fine-grained beds consist mainly of pellets of carbonatite, of chloritic material (meimechite) and of meimechitic carbonatite as described above, cemented by calcite. The diatreme breccias have already been described.

Chemistry

24 chemical analyses of the carbonatites have been prepared of which 16 have been published previously (Dimroth 1970a). They are listed in table 20.

The rocks belong to an alkali-ultramafic suite rich in Al_2O_3, TiO_2, CaO, CO_2, P_2O_5 and F. They have generally been desalkalized. A few samples retained considerable potash, and high contents of chloritized biotite in the desalkalized varieties suggests that all had high original potash/soda ratios. The Mg/Fe ratio is low; the ratio between trivalent and bivalent iron is high in meimechites and low in carbonatites. In general the rocks are similar to kimberlites as defined by Dawson (1962, 1967) but they have high iron contents and low contents of combined magnesia and lime. Iron is highly oxidized in the meimechites (analyses 2-5), it is mainly reduced in the garnetiferous mica-peridotite, and in the carbonatites.

Trace element contents (table 19) are also similar to kimberlites. Ni and Cr occur in quantities comparable to ultramafic rocks. Sr, Ba, Nb, La, Zr are enriched, but not to the same degree as is the case in nepheline syenites and in their carbonatitic suites.

CO_2, SiO_2, and Fe_2O_3 show a regular variation with the carbonate silica ratio. FeO, MgO, and CaO are scattered; on the whole FeO increases first with increasing carbonate, and decreases in the last stages. MgO decreases, and CaO increases with carbonate content.

Origin

Dimroth (1970) concluded that the primitive magma of this suite had an alkali-ultrabasic composition and contained much CO_2 and H_2O. The separation of carbonatites and meimechites is supposed to be due to liquid immiscibility between silicatic and carbonatic liquids. The carbonatites were further fractionated in function of the pressure. The mechanism of the fractionation of the carbonatites is unknown. Ca-rich carbonates formed at low pressures, i.e. at high levels of the diatremes, Ca-Mg carbonates (ankerite-rich) formed at high pressures (i.e. deeper in the diatremes).

Table 20: Analyses of carbonatites and meimechites

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20*	21*	22*	23*	24
	P29-5	D23-27	P26-5	5B1	P26-20	W26-9	W26-7	P30-4	15B3	W35-3	2B1	15B2	14B1	14B3	17B1	4B1	11B5-1	11B2	8B5-2	W22-7	P26-4	4B3	6B3	11B5-2
SiO_2	30.44	33.23	35.02	34.18	31.44	31.31	23.60	29.24	27.97	27.92	22.65	19.34	16.77	15.94	11.42	14.39	17.22	17.95	20.65					2.61
TiO_2	3.48	3.79	2.33	2.38	4.24	3.38	3.27	3.92	3.74	3.78	1.03	5.00	4.12	3.28	0.22	3.90	0.02	1.82	0.47			1.25	1.28	0.00
Al_2O_3	3.37	3.40	2.11	2.20	4.37	3.55	3.57	3.93	3.08	2.58	3.75	3.90	4.46	1.57	2.36	3.41	0.20	4.57	4.32					0.03
Fe_2O_3	4.46	10.71	9.15	8.79	11.83	0.65	0.74	2.31	5.81	1.16	1.29	2.36	0.56	1.98	1.92	1.34	0.91	1.46	1.91					0.56
FeO	14.42	7.67	7.51	7.43	7.59	14.38	16.65	14.55	12.01	14.48	7.07	16.15	12.04	12.25	13.87	7.58	7.45	10.54	8.92	9.26	5.51	4.87	6.72	7.20
MnO	0.31	0.50	0.29	0.29	0.27	0.21	0.26	0.23	0.25	0.28	0.43	0.22	0.45	0.47	0.74	0.51	1.33	0.42	1.30	0.29	0.6	1.65	0.77	n.d.
MgO	18.12	23.55	23.61	21.39	19.12	11.68	14.73	16.38	16.71	18.93	6.48	12.35	11.54	14.77	9.05	4.06	12.03	11.09	9.47	6.54	1.69	1.70	2.65	15.37
CaO	13.88	4.35	6.62	8.99	9.47	10.09	7.71	10.22	10.46	5.75	24.30	14.42	20.37	16.94	21.95	32.35	23.19	18.31	20.33	20.96	22.19	38.80	29.55	29.15
Na_2O	0.03	0.07	0.09	0.10	0.05	0.03	0.03	0.03	0.03	0.05	0.11	0.04	0.03	0.02	0.67	0.04	0.02	0.41	0.24					n.d.
K_2O	0.72	0.34	0.36	0.83	0.04	0.02	0.03	0.03	0.03	0.01	1.34	0.04	0.02	0.02	0.63	0.22	0.55	1.60	2.05					n.d.
CO_2	0.59	4.70	4.56	6.59	4.43	21.40	20.98	12.69	14.62	21.63	24.85	27.33	25.00	29.20	31.00	27.92	36.73	29.08	26.25	27.09	19.92	33.54	22.65	44.25
P_2O_5	0.35	0.68	0.59	0.61	0.51	0.29	0.61	0.99	0.69	0.20	5.42	1.92	0.86	0.45	3.28	0.77	0.03	0.85	1.97			0.39	0.45	0.28
S	0.10	0.23	0.17	0.18	0.21	0.15	0.14	0.38	0.15	0.12	0.21	0.16	0.13	0.36	0.85	0.52	0.15	0.15	0.14					n.d.
F	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.30	n.d.	n.d.	1.27	n.d.	n.d.	n.d.	n.d.					n.d.
H_2O+	7.37	6.08	6.96	5.45	5.94	2.23	1.43	4.56	3.93	2.88	0.75	4.36	3.09	2.12	0.67	2.43	0.30	1.54	1.26					0.71
H_2O-	0.08	0.20	0.14	0.14	0.11	0.04	0.03	0.10	0.03	0.08		0.06	0.03	0.05	0.14			0.09	0.08					
Cr_2O_3	0.11	0.09	0.10	0.11	0.11	0.11	0.08	0.05	0.13	0.07	0.006	0.06	0.10	0.10	0.004	0.13	0.005	0.12	0.007			0.05	0.09	n.d.
NiO	0.07	0.09	0.10	0.14	0.07	0.07	0.06	0.06	0.07	0.06	0.009	0.02	0.07	0.06	0.004	0.5	0.007	0.07	0.003			0.02	0.03	n.d.
CoO	0.002	n.d.	n.d.	n.d.	0.003	0.002	n.d.	n.d.	0.005	n.d.	n.d.	0.003	0.003	0.005	n.d.	n.d.	n.d.	n.d.	n.d.			n.d.	n.d.	n.d.
SrO	0.03	0.005	0.007	0.01	0.14	0.10	0.06	0.07	0.09	0.02	0.11	0.18	0.15	0.26	0.20	0.08	0.07	0.20	0.04	0.22	0.05	0.39	0.35	0.05
BaO	0.03	0.007	0.004	0.02	0.02	0.01	0.01	0.02	0.01	0.002	0.05	0.02	0.01	0.005	n.d.	0.02	0.02	0.27	0.29	0.02	0.02	0.22	0.37	0.02
Nb_2O_5	0.01	0.014	0.014	0.007	0.03	0.01	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.01	0.04	0.02	0.007	0.014	0.014			0.014	0.014	n.d.
La_2O_3	0.01	0.012	0.005	0.01	0.01	0.01	1	n.d.	0.02	n.d.	0.05	0.02	0.0	0.01	0.05	0.04	0.004	0.01	0.02			0.02	0.01	n.d.
ZrO_2	n.d.	n.d.	n.d.	0.035	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.05	n.d.	n.d.	n.d.	0.05	0.035	0.00	0.00	0.03			0.03	0.04	n.d.

Explanation

1. garnetiferous a-peridotite
2-4. meimechitic lapilli tuff
5. meimechite
6-14. biotite carbonatites and carbonatites
15. apatite-fluorite carbonatite
15-17. flow-layered carbonatites
18. austolithic carbonatite breccia
19. heterolithic carbonatite breccia with few foreign.
20-21. heterolithic diatreme breccias, partial analyses
22-23. tuff breccias, partial analyses
24. dolomite vein

* partial analysis of HCl-soluble fraction. TiO_2, Cr_2O_3, NiO, Nb_2O_5, La_2O_3, ZrO_2 from total rock.

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Final Geological Map

of the

CASTIGNON-ROMANET LAKE REGION

by

Erich Dimroth

LEGEND

PLEISTOCENE AND RECENT

25 sand, gravel, peat, till

PRECAMBRIAN

LATE PROTEROZOIC OR PHANEROZOIC

24a carbonatite

24b meimechite and alnoitic rocks

MIDDLE PROTEROZOIC (APHEBIAN)

MONTAGNAIS GROUP

23 medium-grained amphibolite (Metamorphic equivalents of 22a, 22b or 22c)

22a medium-grained gabbro

22b coarse-grained gabbro

22c greenstone

KNOB LAKE GROUP

Mista~~scini~~misk Formation

21a fine grained massive or pillowed basalt

21b black and grey, laminated slate, siltstone, some sandstone

Menihek Formation

20a black and grey laminated slate, some quartzite

20b dark olive green laminated or massive quartzite, some slate

FERRIMAN SUBGROUP

Sokoman Formation

19a	lower hematite ironstone member, or hematite ironstone in general
19b	middle silicate-carbonate ironstone member; or silicate-carbonate ironstone in general
19c	black intraclastic chert in 19b
19d	hematite ironstone in 19b
19e	upper hematite ironstone
19f	upper silicate-carbonate ironstone

Ruth Formation

18a	dark grey laminated or massive siltstone, some laminated slate at base
18b	iron shale
18c	iron siltstone
18d	jaspilite or black chert

Wishart Formation

17	grey sandstone, some grit, some fine grained sandstone and argillite

ATTIKAMAGAN SUBGROUP

Bacchus Lake Formation

16a	black and grey slate, grey siltstone, subordinate brown dolomite, massive beds of sandstone at top of formation
16b	fine grained massive and pillowed metabasalt
16c	hyaloclastic basalt
16d	biotite schist, biotite quartzite, biotite-amphibole schist
16e	fine grained meta-basalt amphibolite
16f	prasinite

SWAMPY BAY SUBGROUP

Romanet Formation

15a	graphitic slate, minor graywacke
15b	black graphitic greywacke, some grit, conglomerate, interbeds of graphitic slate
15c	dolomite conglomerate

Du Chambon Formation

14a	graphitic slate, minor graywacke locally dolomite interbeds
14b	graphitic slate, much black, graphitic greywacke
14c	grey, white or rusty brown weathering nodular quartzite (conglomerate with sandstone pebbles?)

Otelnuk Formation

13a	mainly grey, laminated slate,minor greywacke
13b	mainly greywacke, minor grey, laminated slate
13c	slate and greywacke in equal proportion
13d	laminated slate, siltstone and fine-grained greywacke

Savigny Formation

12a	grey, mild, silt-laminated slate
12b	black, graphitic greywacke

Hautes Chutes Formation

11	black, graphitic slate

PISTOLET SUBGROUP

Pistolet Subgroup, not subdivided in Formations

10a	pink arkosic conglomerate
10b	white massive quartzite, locally dolomitic
10c	red siltstone and fine grained sandstone, interbeds of purple sandstone and white quartzite

10d	dolomitic sandstone
10e	grey, laminated, siltstone and shale, beds and lenses of brown weathering dolomite
10f	massive, dark grey, chocolate brown weathering dolomite and sandy dolomite
10g	dolomite, some dolomitic sandstone and white quartzite 10a-10d and 10g correspond essentially to the Alder Formation, 10e and 10f to the Uvé Formation
	<u>Uvé Formation</u>
9a	grey, or yellow, chocolate brown or buff weathering, massive dolomite
9b	grey, dark brown weathering, dolomitic sandstone
9c	white massive quartzite
9d	red and green laminated siltstone and very fine grained sandstone, some interbeds of grey, brown weathering dolomite
9e	grey laminated argillite and siltstone, some interbeds of grey, brown weathering dolomite
9f	grey laminated siltstone and very fine-grained sandstone
	<u>Alder Formation</u>
8a	light grey, white or cream weathering stromatolitic dolomite
8b	dark brown weathering, grey, dolomitic sandstone
8c	interlayered sequence of 8a and 8b
8d	same as 8c, but dolomitic sandstone predominantly
8e	brown or cream weathering calcarenite
8f	white, massive quartzite
8g	interlayered sequence of 8b and 8c
8h	conglomerate with gneiss pebbles
8i	red and green siltstone and very fine-grained sandstone, some interbeds of red or orange weathering dolomite
8j	grey argillite and siltstone

Lace Lake Formation

7(1) to 7(5) members 1 to 5 as at type locality

7a	grey, laminated argillite or shale and siltstone, beds or lenses of brown weathering dolomite
7b	green and or red laminated siltstone and very fine grained sandstone and grey argillite, beds or lenses of brown weathering dolomite
7c	same as 7a but devoid of dolomite beds
7d	same as 7b but devoid of dolomite beds
7e	grey, green and purple siltstone, and fine grained sandstone, some dolomitic sandstone
7f	white or brown weathering, grey nodular quartzite, underlain by slate

SEWARD SUBGROUP

Milamar Formation

6	meta-arkose, arkosic meta-conglomerate with gneiss pebbles, very coarse quartzite, grit

Dunphy Formation

5a	greenish grey laminated siltstone, grey and black shale, some very fine grained sandstone
5b	greenish grey siltstone, some grey shale, interbeds of grey, brown weathering dolomite
5c	white quartzite alternating with green to grey laminated siltstone
5d	grey and black shale, some greenish grey laminated siltstone
5e	pink or salmon coloured stromatolitic dolomite
5f	pink and white stromatolitic dolomite, alternating with grey, brown weathering sandstone; locally ankeritized

Du Portage Formation

4a	dark red very fine grained arkose and arkosic sandstone, locally green beds
4b	red very fine grained arkosic sandstone, red sandstone, dolomitic sandstone and calcarenite

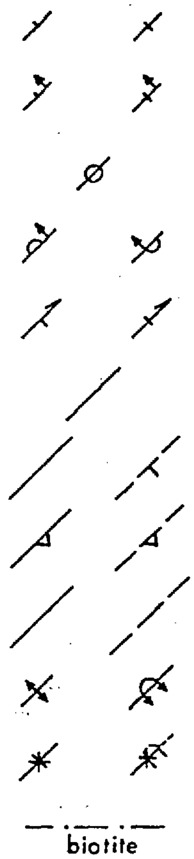
4c	pink or salmon coloured stromatolitic dolomite
4d	red and pink coarse-grained dolomitic sandstone and calcarenite
4e	white or light pink quartzite
	Chakonipau Formation
3a	dark red, very fine grained arkose
3b	pink, medium grained arkose and arkosic grit; locally white or green coloured
3c	alternating pink medium-grained arkose, arkosic grit, and arkosic pebble conglomerate
3d	pink, arkosic pebble conglomerate, some grit
3e	pink, arkosic boulder conglomerate
3f	quartz-albite-sericite schist
3g	pink arkose, some pink pebble conglomerate, minor calcarenite and calcilithite, locally green siltstone. May in part be equivalent of du Portage formation

ARCHEAN

	WHEELER COMPLEX
2a	anatectic and diatectic biotite-amphibole gneiss
2b	plagioclase amphibolite
2c	pegmatitic gneiss
2d	phyllonitic albite-biotite-sericite gneiss
	ASHUANIPI COMPLEX
1a	anatectic and diatectic biotite amphibole gneiss
1b	pink, coarse grained, porphyritic granite, dykes of granite porphyry
1c	same as 1b, sheared

SYMBOLS

a) b)



a) outcrop; b) outcrop area

stratification, top unknown; a) dipping, b) vertical

stratification, top known; a) normal, b) overturned

pillows, top unknown

pillows, top known; a) dipping, b) overturned

cleavage or schistosity; a) dipping, b) vertical

geological contact

normal fault a) defined; b) assumed

thrust fault a) defined; b) assumed

fault with unknown movement a) defined; b) assumed

anticline a) upright; b) overturned

syncline a) upright; b) overturned

metamorphic isograde

Scale 1:32,000

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